621.06
A51
M

THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Engineering Library
PERIODICAL ROOM
RECEIVED
OCT 8 1915
UNIV. OF MICH.
LIBRARY

· OCTOBER · 1915 ·

ANNUAL MEETING, NEW YORK CITY, DECEMBER 7-10

THE SOCIETY OF THE INDUSTRIES

THE growing prominence of the mechanical engineer in every field of industrial activity, and the great influence and value of intimate association with a recognized organization of engineers have suggested the propriety of calling wider attention to the advantages of membership in The American Society of Mechanical Engineers and the prestige and privileges which accompany such a connection.

Mechanical engineering is inclusive of all branches of engineering and as a profession may properly be said to include a very wide range of highly specialized subjects. The American Society of Mechanical Engineers—*the Society of the industries*—constantly endeavors to make adequate provision for its members in each branch of engineering, in order that those who so desire may put all of their energies into the development of the particular field in which they are engaged.

The Secretary or any of the following members will be pleased to give further information regarding the Society.

COMMITTEE ON INCREASE OF MEMBERSHIP

I. E. Moultrop, *Chairman*	R. M. Dixon	E. B. Katte
F. H. Colvin	W. R. Dunn	R. B. Sheridan
J. V. V. Colwell	J. P. Ilsley	H. Struckmann

CHAIRMEN OF SUB-COMMITTEES

Atlanta, Park A. Dallis	New Haven, E. H. Lockwood
Boston, A. L. Williston	New York, J. A. Kinkead
Buffalo, W. H. Carrier	Philadelphia, T. C. McBride
Chicago, P. A. Poppenhusen	Rochester, J. C. Parker
Cincinnati, John T. Faig	St. Louis, John Hunter
Cleveland, R. B. Sheridan	St. Paul, Max Toltz
Detroit, H. H. Esselstyn	San Francisco, F. H. Varney
Los Angeles, O. J. Root	Seattle, R. M. Dyer

Troy, Albert E. Cluett

Applicants for membership who apply by October 25th and receive favorable consideration, will be listed in the 1916 Year Book.

Total Membership of the Society, September 24, 1915	6570
New Members since January 1, 1915	481

The Exposition Number

THE present issue of The Journal might well be termed the Panama-Pacific International Exposition Number, as the proceedings section is devoted entirely to the two papers on the Exposition presented at the September meeting at San Francisco.

Both these papers were written by members residing in San Francisco, and both are replete with first-hand information, as both authors have been intimately connected with the Exposition itself.

The paper on "Engineering Features of the Panama-Pacific International Exposition" is a comprehensive description of the work of the engineering department of the Exposition, of which the author, Guy L. Bayley, Mem. Am. Soc. M. E., has been Chief Mechanical and Electrical Engineer since 1911.

"Mechanical Engineering at the Panama-Pacific International Exposition" is a thorough-going review of the engineering exhibits, by George W. Dickie, Vice-President Am. Soc. M. E., who was a member of the Grand Jury of Awards and was chairman of the Departmental Jury on Tools for Shaping Wood and Metals.

THE JOURNAL OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 37 OCTOBER 1915 Number 10

CONTENTS

SOCIETY AFFAIRS

The San Francisco Meeting (V). Correspondence Departments for The Journal (X). Report of the Nominating Committee (X). The Annual Meeting (X). F. W. Taylor Memorial Meeting (XI). Naval Advisory Board (XI). Yale Engineering Association (XIII). Report of the Joint Committee on the Reserve Corps of Civilian Engineers (XIV). International Gas Congress (XIV). Applications for Membership (XV).

PROCEEDINGS SECTION

Engineering Features of the Panama-Pacific International Exposition, G. L. Bayley 571

Mechanical Engineering at the Panama-Pacific International Exposition, George W. Dickie ... 592

REVIEW SECTION

Engineering Survey 601

SOCIETY AND LIBRARY AFFAIRS

Necrology 615

Personals 615

Employment Bulletin 616

Accessions to the Library 618

Officers and Committees 620

PROFESSIONAL AND EDUCATIONAL DIRECTORY

Consulting Engineers 2

Engineering Colleges 4

ADVERTISING SECTION

Display Advertisements 7

Classified List of Mechanical Equipment 42

Alphabetical List of Advertisers 57

PUBLISHED MONTHLY BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West Thirty-ninth Street, New York

PRICE 35 CENTS A COPY, $3.00 A YEAR; TO MEMBERS AND AFFILIATES, 25 CENTS A COPY, $2.00 A YEAR. POSTAGE TO CANADA, 50 CENTS ADDITIONAL; TO FOREIGN COUNTRIES, $1.00 ADDITIONAL

C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Entered as second-class matter, January 4, 1912, at the Postoffice, New York, N Y., under the act of March 3, 1879

ANNUAL MEETING, 1915

New York City, December 7 to 10

Textile Session: Papers on the relative values of individual power plants in textile mills and purchased electric current; hot water heating of textile plants, and engineering features of insurance.

Railroad Session: Discussion of trucks for passenger coaches.

Protection of Industrial Workers Session: Papers on safety methods in the engineering industries, compensation laws, economic advantage of safety appliances.

Papers contributed by the Committee on Machine Shop Practice, covering mechanical and electrical control of machine tools.

Papers contributed by the Committee on Industrial Buildings, dealing with building foundations.

Paper contributed by the Research Committee, on mechanical strength of porcelain and stoneware.

Papers contributed by Junior Members for the Junior Prize.

MEETINGS OF LOCAL SECTIONS

October 6, *St. Louis, Mo.* Subject: The Little River Drainage District, by William A. O'Brien.

October 12, *New York.* Subject: Motion Study for Crippled Soldiers, by Frank G. Gilbreth, Mem. Am. Soc. M. E.

October 13, *Boston, Mass.* Joint meeting under the auspices of the A. I. E. E. Subject: Load Dispatch Board as used by the Edison Electric Ill. Co. and Boston Elevated Ry. Co.

October 21, *Buffalo, N. Y.* Subject: The Training of Young Mechanics, by W. B. Humper, Director of the Pittsburgh High School.

October 27, *St. Louis, Mo.* Subject: Telescopes, by Dr. John A. Brashear, President of the Society.

November 4, *Buffalo, N. Y.* Subject: Multiplicity of Cylinders in Automobiles, by J. G. Vincent, Mem. Am. Soc. M. E. and Vice-President of the Packard Motor Car Company.

November, New Haven, Conn. Subject and date of meeting to be announced.

November 19, *Chicago, Ill.* Subject of meeting to be announced.

THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 37 October 1915 Number 10

THE SAN FRANCISCO MEETING

THE Society was notably represented at the national gathering of engineers in San Francisco last month to pay personal tribute to the builders of the Panama Canal, and its own September meeting was attended by a large proportion of the members resident in San Francisco and by others from all sections of the country. The meeting of the Society took place on Thursday, September 16, and Friday, September 17, three days prior to the International Engineering Congress, which convened on Monday, September 20.

The members of the Society who went out to the meeting from New York journeyed to San Francisco on the Engineers' Special which had been arranged for the convenience of the members of the National Engineering Societies visiting the Panama-Pacific International Exposition and the Engineering Congress. This train left New York on the evening of Thursday, September 9, carrying a party of 169 members of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers and The American Society of Mechanical Engineers, with ladies and guests. The trip across the continent was made over the New York Central and Santa Fé lines, stops being made *en route* at points of scenic interest. Representatives of the various local committees of the Societies came aboard the train before it arrived at Oakland, Cal., to welcome the visitors and to assist in conducting them to their respective hotels. The party arrived in San Francisco on the evening of September 15.

The headquarters of the Society was the Clift Hotel, where registration was begun as soon as the party from New York arrived. The local arrangements were in the hands of the San Francisco committee, F. W. Gay, *Chairman*, F. H. Varney, *Vice-Chairman*, C. F. Braun, *Secretary*, H. L. Terwilliger and J. T. Whittlesey. Acknowledgment of the work of these gentlemen, which resulted in such a successful meeting, should be made.

The opening session of the September meeting was held in the Hall of the Native Sons of the Golden West at 10 o'clock on the morning of September 16, and the meeting and subsequent events are described in the following communication received from Calvin W. Rice, Secretary of the Society.

"The events since arriving have been the regular morning session on Thursday, opened by the President of the Exposition, Charles C. Moore, extending the welcome on behalf of San Francisco and the State of California, to which President Brashear responded. I have also sent the remarks prepared by Mr. Dickie, in reply to Mr. Moore. The remainder of the morning session was appropriately devoted to two papers bearing on the Exposition, one by Mr. Bayley, chief engineer of construction of the Exposition, who presented a comprehensive paper on the engineering features of its building; and the other by Mr. Dickie, dealing with the features of mechanical engineering interest embodied in the exhibits. After the session we all took busses to the Exposition grounds where a lunch was tendered by the local members. From the Old Faithful Inn, we proceeded in Fadgl trains around the Exposition grounds terminating in the Court of Abundance, where the President of the Exposition presented a commemorative medal. This was received by Dr. Brashear on behalf of this Society.

In the evening there was an informal dinner of the Civil Engineers in the Old Faithful Inn, and also a dinner-dance under the auspices of the Electrical Engineers at the Hotel St. Francis, to both of which functions our members were invited. At the latter function the President and Secretary and the Past Presidents of the Mining Engineers and Mechanical Engineers were present as guests of the Electrical Engineers.

Friday, at the professional session in the forenoon, the two papers on Oil and Diesel Engines by Messrs. Goldingham and Adams, respectively, and the one on Gear Teeth by Professors Marx and Cutter were presented, followed by an interesting discussion.

At the conclusion of this session, the Officers of the Society took a bus to the Exposition grounds, where we were the guests at a lunch tendered by the President of the Exposition. There were present, Dr. John A. Brashear, Jesse M. Smith, Geo. W. Dickie, Prof. W. F. Durand, Ira H. Woolson, Guy L. Bayley, Gano Dunn, W. R. Warner, John A. Freeman, W. L. Saunders, H. G. Reist, Chas. Whiting Baker, F. W. Gay and Calvin W. Rice of the Society; Mr. Lynch, Vice-President of the Chamber of Commerce; Mr. Arlett, representing the Governor of California; Mr. Mark-

wart, formerly Associate Director of Works and to whom much of the credit should properly be given for the construction work of the Exposition; Mr. Brown, a director of the Exposition; Col. Hetherington, Pennsylvania State Commissioner; Mr. Connick, Director of Works of the Exposition; Mr. Hardee, Director of Functions, and the two aides of President Moore, Lieutenant Commander Woodward and Captain Carpenter. Mr. Moore acted as toast master, and after a toast to the President of the United States and the Governor of Pennsylvania, welcome was extended on behalf of the Exposition authorities by Director Brown. Recognition of the engineer was given in connection with the rebuilding of San Francisco after the terrible conflagration, and that the successful completion of the Exposition was due to the Engineer.

Inasmuch as our President, Dr. Brashear, was the person designated by the Governor of Pennsylvania as the most distinguished citizen of that State, mention was made of that fact by Director Brown.

Mr. Arlett, representing the State, followed, and expressed a wish that all the engineers would obtain the vision which the officials had had before them in all their work in connection with this International Exposition.

Col. Hetherington next spoke, having gotten up from a severe illness in order to attend the luncheon. He stated that Pennsylvania had sent to the Exposition two great exhibits—the Liberty Bell and Brashear.

W. L. Saunders, President of the Mining Engineers, was next called upon and facetiously called attention to the fact that this was "Mining Engineers' day" notwithstanding that this luncheon was tendered to the Mechanical Engineers. Mr. Saunders showed the part that mining had played in the development of California's greatness, and in fact, California's contribution to the prosperity of the entire country.

Mr. Gano Dunn, President of the United Engineering Society, stated that while credit should be given the Engineer, we should also remember that it is the artist, the lawyer, and those moved by the religious instinct who should receive recognition, equal with the Engineer, for the imagination essential to the construction of any great work. It was essential for one to have an imagination in order to be considered as truly participating in life. A tribute was paid to President Moore, whom Mr. Dunn had seen three years previous in connection with the meeting then proposed for the International Electro-Technical Commission, and that Mr. Moore had made good his most ambitious promises.

Mr. Dickie was called upon in his capacity as one of our representative engineers, responsible for much of the engineering of the Coast.

Then followed Mr. Markwart, speaking for the engineering staff of the Exposition. He forcefully brought out that the Engineer did have all the imagination essential to the construction and execution of the Exposition—and to the dismantling besides. He had to imagine a lake and a swamp made into a city. In round numbers, the Exposition had cost $18,200,000, $14,000,000 of which had been expended under the direction of the engineering staff.

Dr. Brashear concluded the remarks by referring particularly to California's contribution through the Lick Observatory, and particularly urged engineers to have as their main motive of life that of helping others.

President Moore closed the luncheon by a toast drunk to the Progress of Engineering and Scientific Accomplishment.

Quite a number then accompanied President Saunders to the Count of Abundance, where ceremonies similar to those of Thursday were in progress, Director Brown, on the part of the Exposition, presenting a commemorative medal to the Institute of Mining Engineers.

In the evening, the A.I.M.E. held a successful banquet at the Palace Hotel at which the President, Secretary and Past Presidents of the Electrical Engineers and Mechanical Engineers were guests.

Next week are the events of the International Engineering Congress. Besides the professional sessions there will be on Monday evening, the Congress reception, and on Friday evening the Congress banquet.

On Wednesday, in honor of Dr. Brashear, they are to have "Brashear Day" at the Exposition, when we understand a medal will be presented to Pennsylvania's most distinguished citizen.

Friday, will be "Engineer's Day."

CALVIN W. RICE, Secretary.

September 18, 1915.

REPLY TO ADDRESS OF WELCOME BY CHARLES C. MOORE.

BY GEO. W. DICKIE, MEM. AM. SOC. M. E.

The duty of replying to your very kind address of welcome, devolves upon me as Vice-President of this Society. This, sir, is not the first meeting of this Society in San Francisco. On May 16, 1892, this Society began a memorable meeting in the reception parlor of the old Palace Hotel. There the members were welcomed to the Pacific Coast by his Honor, Mayor George H. Sanderson. Mr. Robert W. Hunt replied in graceful terms, and thus the meeting was formally opened. The local committee who made the arrangements for that meeting were Wm. R. Eckart, Chairman, Charles G. Gale, Secretary, G. W. Dickie, James Spiers, John Richards, Marsden Manson, E. J. Molera, H. J. Small and Frank Van Veck. Some of these have answered to the last call, while the others are still doing something to help along the things they think should never go to the scrap heap. It is very fitting, sir, that you should bid us welcome at this time, as we are here like many others to help celebrate the greatest engineering achievement of our time, the cutting in two of the Western Hemisphere, joining the two great oceans of the world, forming a new pathway for the world's commerce. Our great Exposition that celebrates the completion of this great work, has developed into a thing of wondrous beauty, with you, sir, as its guiding head. It is true that another engineering society will naturally claim first honors in the great work that we celebrate, yet it must never be forgotten that the civil engineer can not go very far in any work he undertakes without the active help of the mechanical engineer. If he wants to dig either a big or little ditch, and needs a shovel for the purpose, either an ordinary 25 lb. hand shovel or a fifteen ton steam shovel, he must get the mechanical engineer with him before he can do any digging, and at this time it is worth while remembering that nearly all the great work carried out under the civil engineer is necessary, because of what the mechanical engineer has been doing. The great steamships that originate with the mechanical engineer, made the Panama Canal a necessity. The locomotive engine, with its long line of cars, makes necessary the tunnels and bridges that the civil engineer constructs for their passage. In fact,

nearly all great modern works of which the civil engineer is so justly proud, have been produced in order that the work of the mechanical engineer may either run over or through them. The work of the civil engineer is more spectacular and more in the public eye, thus exciting admiration that is reflected on the designer and builder.

Sailing on one of the Hudson River day steamers, up that splendid river about two years ago, I saw ahead an airy structure spanning the river at a great height, looking like a huge spider web, too attenuated in appearance to serve any practical purpose, but as the boat came nearer, the stability of this structure became more apparent, and admiration of the boldness of it began to take possession of my mind, then something appeared at one end of this airy structure, and quickly took possession of it as a pathway to the other side. Here was the explanation of it all. The mechanical engineer needed the Poughkeepsie Bridge for his locomotive and train to cross the river, and he also needed the river for his steamer, and so we find as we contemplate the work of these great branches of engineering, that they are "Useless each without the other." The one is static, that is engineering in repose, the other dynamic—engineering in motion, and they are every day becoming more important factors in the work of the world. Even war has now become largely a job for the mechanical engineer, and seeing that we can neither live comfortably, nor die bravely without the help of the mechanical engineer, his position among the useful elements of society should be improved, so that he would occupy a place in the estimation of his fellow men commensurate with the indispensable character of the service he renders to the world. I would not seek a higher place for the mechanical engineer than that which is freely granted the civil engineer, but it should not be lower, and it is one of the functions of the Society that I represent here today, to help the mechanical engineer find his true place among the professional men of his time.

To the 6,000 members of this Society, the country is largely indebted for the position she occupies among the nations of the earth, that she is able to furnish other nations with so many implements through which progress is made, is largely due to the work accomplished by members of this Society. That the reward that comes to them financially is not what it ought to be is shown by the small percentage of our members who have been able to cross the continent, and see the wonderful dream that has become a fact, sir, under your direction—and attend the meetings to be held here. This is to be regretted, but cannot be helped. Engineers as a rule do not acquire wealth, and perhaps it is just as well for them that they don't—there would be less good work done if it were better paid for. The best work that has ever been done for this old, ungrateful world of ours, was never paid for. You can't do the things that you think ought to be done, if you wait for a contract insuring pay before you do them. Many noble engineers still do the things they love to do without any thought of pay, and so long as that is the case, we can well be proud of our profession. The present President of this Society is a splendid example of the character of man I refer to. It has often been said of the family I belong to, that they would rather build ships and starve, than do anything else and become rich, and I trust they will continue in that frame of mind. And now, sir, accept the thanks of this Society in the welcome you have given us to San Francisco, and in behalf of the members, here present, and the great number belonging to us all over this great country, we thank you very cordially for giving us your presence this morning, and for the kind words you have spoken to us on this occasion.

PRESENTATION OF COMMEMORATIVE MEDAL, THURSDAY, SEPT. 16TH

On behalf of the Exposition, President Moore presented a commemorative medal to the Society in recognition of their having held their meeting in this City at the time of the Exposition. Opening remarks were made by Mr. Dickie, Vice-President of the Society, in which he emphasized the obligation of the world to the engineer. President Moore responded stating that as an engineer this was a hey-day of the Exposition and he expressed great satisfaction in being able to meet members of the Engineering Societies personally.

The Exposition was under great obligations to the Engineering Societies indirectly, and to the members of his staff, directly, for much of its success and beauty.

"God made the World, but the Engineer made it to live in."

One definition which appealed to Mr. Moore was that in our constitution "To adapt the achievements of arts and science to the use of man." President Moore stated that the purpose of the Exposition is to leave enduring high aspirations and high thoughts for the advancement in human brotherhood. The success of the Buffalo Exposition can be credited largely to Mr. Newcomb Carlton, an engineer, and similarly all the activities of this Exposition have been directed by engineers, in fact, the profession dominated the Exposition.

Dr. Brashear responded with heartfelt appreciation. He referred particularly to the monument to Samuel Pierpont Langley, which he had seen on the way to the Court of Abundance. He spoke of the progress of engineering and compared it to the strides in the art of photography. He had had a conversation, when a young man, with a woman who had sat sixty minutes for her photograph, and it wasn't so long ago when one had to sit seven minutes. Now we can not only take a photograph of the cannon ball going through space at the rate of 1500 ft. a second, but also can finish it quickly, as emphasized on this occasion, where a photograph of the company assembled had been taken and prints distributed before the ceremonies were concluded.

The work of the world is yet to be done. Sir Isaac Newton, at the time he was dying, stated that he was as a child who had simply gathered a few shells, whereas the whole ocean of truth lies before us.

After Dr. Brashear's response, Professor Durand followed with an address on the progress of mechanical engineering in the service of humanity.

PROGRESS IN THE FIELD OF MECHANICAL ENGINEERING DURING RECENT YEARS

BY W. F. DURAND, MEM. AM. SOC. M. E.

I take it that, in its deeper significance, the ceremonial in which we are assisting this afternoon, is intended to signalize the work of the mechanical engineer in the service of humanity, and in this thought I shall refer briefly to some few of the larger fields into which we are called in this service, and to some of the more important achievements which have been made in these fields.

First in answer to the broad query, What is the field of service of the mechanical engineer? I like to picture him in mind as a great high priest of Nature whose duty it is to stand between the mighty stores of energy which she holds for the service of humanity, and the insistent demand for energy and more energy, as the one universal and essential element in the fabric of our present day civilization.

We have heard in history of the age of stone, the age of brass, of iron, of gold; but in a very real and literal sense the present is the age of energy, an age in which the entire fabric of our civilization is built upon the liberation and utilization of the inorganic agencies and energies of nature.

Pause only for a moment to consider our state, were there available for our present day life, no energy other than that which we might furnish by our own hands, or by the aid of domesticated animals. Consider the essential elements of our everyday life; the raiment we wear, the food we eat, the houses in which we dwell, the means for carrying on the complex systems of intercommunication between man and his fellow. Remove the supply and the methods and means for utilizing the energies of Nature for these purposes and what have we left? Our entire present civilization with its wonderful achievements and complex interrelations, crumbles away and disappears.

And so it is that peculiar function of the mechanical engineer to stand as the interpreter and the purveyor of natural energy in the service of humanity.

The sources of such energy are well known. Those with which we are chiefly concerned are, on the one hand, the hydro-carbon supplies, now existing in the form of gas, oil, or coal, and stored up in past geologic ages for our present day service, and, on the other, hydraulic sources, representing the present day energy of the sun in lifting the water into the air in the form of vapor, whence it is precipitated as rain or snow, collected on high mountain watersheds and ultimately, in seeking its lower level in the sea, may be made to turn our water-wheels and thus furnish energy in electrical or mechanical form as we may desire.

Again in serving the needs of civilization as the interpreter and purveyor of energy, the functions of the mechanical engineer are manifold and not easy of rational classification. Broadly, however, his field of work may be indicated under the following chief heads:

(1) The transformation of energy from the unavailable form in which Nature holds it, into the directly available or dynamic form as embodied in the motion of a prime mover such as a steam or internal combustion engine, steam turbine, or water-wheel; and the design, construction, and application of prime movers in special forms to the driving of steam ships, railway trains, or other special and direct modes of application.

(2) The transformation, by means of devices and mechanisms, of the mechanical energy furnished by a prime mover, into modes of motion suited to the manifold demands presented by the various industrial arts. Thus every machine driven tool for the forming of parts of other machinery or of structures, every mill and factory wheel, in short every cunning device of industry—all represent the application of a mode or means of transforming and thus utilizing mechanical energy.

(3) The organization and management of industrial systems, whereby, through the combination of mechanical energy, raw material and human directive agency, the products of the arts and industries may be most effectively provided.

While the work of the mechanical engineer is by no means hemmed in by the arbitrary boundaries indicated in these categories, and while either along or in co-operation with his brother engineers in other fields, he renders signal service to humanity, nevertheless the three categories noted above represent his most significant and characteristic fields of work and I shall refer, only briefly, to some of the notable achievements in these fields during recent years.

In the broad field of power development, the mechanical engineer has rendered some of his most impressive and beneficent service to humanity. In the transformation of the energy from hydrocarbon sources into mechanical form, there are two well known routes—that by way of water in the form of steam as an intermediate agent, and direct, as in the more recent internal combustion prime mover.

The present steam boiler represents a wonderfully refined engineering product. Having in view the conditions under which it must work it represents indeed a marvel of safety and efficiency. So long as we are limited by the present modes of combustion and heat transmission, the present efficiencies of 80 per cent. and upward leave but small margin for improvement. The special lines of advance during the past decade have been in the use of higher steam pressures, more reliable and effective means of producing superheated steam, a close and intensive study of boiler operating conditions resulting in marked advance in capacity, efficiency, and reliability; and finally, marked advance in our understanding of corrosive and deteriorating agencies, and in effective modes of control.

The reciprocating steam engine, as a prime mover, represents mechanically, in its present form, well nigh a completed and perfected mechanism. While in large sizes the turbine is becoming the typical steam prime mover, and while the internal combustion engine now occupies a considerable part of the prime mover field, nevertheless the reciprocating steam engine still holds its own for many purposes, and aside from the automobile engine is undoubtedly more numerously used than all other forms of prime mover combined.

The special lines of development which have signalized the progress in recent years have included the following items:

(1) Better adaptation to the use of superheated steam.

(2) The advent of the una-flow type of engine with a single cylinder, rivalling the results to be obtained by multi-stage engines using the older mode of steam distribution.

(3) Compact and highly efficient small steam power plant units of the so-called locomobile type.

(4) A careful study into and a better understanding of the conditions which determine the economical selection of

steam prime-movers, thus assuring wiser and more economical choice among the many types offered.

In the field of the steam turbine, the mechanical engineer with his brother the electrical engineer have produced, during the past two decades, a complete revolution in the field of power plant engineering, especially as applied to large central station service for electric light and power, and to marine propulsion in both the mercantile and naval services. Huge units are now possible, which a few years ago were far beyond the dreams of power plant engineers, and give at the same time efficiencies hitherto unattainable in steam prime-movers. The steam turbo-electric unit of 30,000 kw. has already arrived and a larger unit of 50,000 kw. is already peeping above the horizon. The progress in this particular part of the field stands out as a bold mountain peak, and when the history of the development of engineering during the early part of the 20th century shall be written, the advance in the application of the steam turbine will furnish one of its most impressive chapters.

No less significant and impressive has been the progress during the past 20 years, and in particular, during the past decade, of the internal combustion engine—the engine which uses gas, gasoline, distillate, kerosene, or crude and fuel oils as its own immediate source of energy. The automobile with all that it means to the world of today, depends for its present widespread service, on the successful solution of the problem of the internal combustion engine. Likewise the aeroplane, and indeed the entire field of heavier than air aeronautics, depends for its very existence on the marvelous refinements which have been wrought in the design of this form of prime mover during recent years. Again, unknown thousands of industrial, economic, and commercial demands for power in relatively small amounts are met effectively and reliably by engines of this type. Again and perhaps no less impressive than the advent of the automobile engine, has been the rapid development during the past decade of the Deisel engine—the engine which carries the prime mover back to the mouth of the oil well or in any case to a form of fuel of the same order of cost as the crude petroleum oil and which gives at the same time a thermal efficiency reached by no other class of heat prime mover. This engine is making rapid and significant progress in stationary practice where power is required in moderate amounts and where overall economy of the order of the steam-boiler steam-turbo plant must be equalled or bettered.

Still more spectacular is the progress of this type of prime mover in the field of marine engineering. Deisel engine power plants for marine propulsion of a horse power capacity in the thousands are now a commonplace of the field of marine construction, while the submarine, with its terrible powers of offence is dependent for its high surface speed, for power to charge its storage batteries for submerged cruising and for its relatively extended radius of action, on the power developed, and the efficiency realized by Deisel engines as perfected in recent years.

Again, in this connection, I should not omit to refer to the magnificent work which has been done in the field of railway engineering, in the improvement of the locomotive, the iron horse which draws our trains with their millions of passengers and countless tons of freight over the railroads which gridiron the inhabited land. In recent years the improvement here has been in refinement of design, improvement in economy and great increase in size and capacity. No more impressive sight perhaps is to be found in this Exposition, in the display of engineering progress, than the two locomotives, in the transportation building, one marking the early pioneer days and the other a modern representative giant of the iron rail.

In the same field likewise, the mechanical and electrical engineer have joined hands and have produced the wonderful electric locomotives now coming into use for special conditions of service, and of which we have in this Exposition a splendid example, nearby the steam locomotives to which I have just referred.

Turning for a moment to the field of hydraulic power engineering, we find in recent years progress, perhaps less spectacular than in some others, but none the less real. The improvements here are concerned with great increase in size, in efficiency, and in general reliability and adaptability in the various fields of service. Here again, joining hands with the electrical engineer, hydro-electric units of 15,000 to 20,000 h.p. capacity and upward, are readily built under suitable hydraulic conditions, and with hydraulic efficiencies close to about 90 per cent—achievements which 20 years ago would have seemed quite beyond the limits of possibility or immediate hope.

But I must hasten on to a few references to achievements in other fields of activity.

In the general field of devices and mechanisms for transforming and utilizing energy in accordance with the demands of the arts and industries, the imagination is staggered by the wealth of material and it is scarcely possible to know where to begin or where to end. One of the notable lines of progress has been in the field of automatics; mechanisms which seem scarcely less than human, and which, in the field of industry, eliminate or reduce to the barest minimum the residuum of human energy or directive agency required, and thus give us the manufactured article as a combination of little beyond raw material and mechanical energy. Again, to take here and there at hazard a few illustrations, mention may be made of the linotype and monotype machines for typesetting, the wonderful printing presses which give us our newspapers, magazines, and books, boot and shoe machinery which has revolutionized this industry in recent years, wonderful looms of the Jacquard type which weave articles of beauty and utility from the raw materials which are supplied, flouring machinery, sugar machinery, wood working machinery, metal working machinery of every kind and purpose, rolling mill machinery for making the steel plates and shapes of which are formed our ships, our bridges, our giant buildings, the rails on which our railroad trains may safely run, machinery for making pipe, tubing, rods, wire—in iron, brass, copper, and in the myriad forms, sizes and patterns which the modern arts and industries require.

These and countless more are all embodiments of ways and means for transforming and utilizing energy, and they represent one of the most diversified and most fruitful of the fields in which the mechanical engineer may serve his day and age. In all of these countless mechanisms, recent years have witnessed signal advance in scope, in adaptation, in economy, and in effectiveness relative to the ends in view.

Turning now, in closing, to the last field which I have mentioned, the organization of industry with reference to the highest economy of useful product, we find most notable advances during the past decade.

The so-called science of industrial management has at-

tracted increasing attention during recent years, and has been the subject of exhaustive studies on the part of many most eminent engineers.

In the accredited pioneer and distinguished leader in this field of work, The American Society of Mechanical Engineers, recognizes one of its own past presidents, Mr. F. W. Taylor, unhappily cut down in the midst of his usefulness in this field.

This is neither the time nor place to discuss in detail the science of industrial management and I can only say here, that as an ideal, it strives to so co-ordinate and combine the duties and responsibilities of capital and of labor, of the highly trained technicians and of the craftsmen in their various grades and degrees of skill, that the products of industry, representing the combination of (1) raw material, (2) human energy and directive skill, (3) mechanical energy, may be realized with the minimum demands on each of these three ingredients, and with the maximum financial reward, fairly divided among all who have contributed to the result.

In this field much of the fundamental work has been well started; much still remains to be accomplished. It is one of the most significant of the fields which have recently attracted the attention of the mechanical engineer, and the past decade will go down in the history of engineering progress as that which witnessed the special groundwork studies which should serve for the development of a wiser and more effective organization of our industrial agencies and forces.

In closing, I only repeat in other words my opening thought. The work of the mechanical engineer enters as an essential element into the daily life and well being of every dweller within the pale of civilized society—whether in sickness or in health, whether high or low in estate, rich or poor, and whether occupied in business or pleasure. It forms that part of the civilization of today which in a peculiar sense renders it distinctive and marks it out from the civilization of earlier ages.

In all this the mechanical engineer should recognize only an opportunity for service to humanity and to the cause of human progress. As mechanical engineers, let us see that we live up to the full measure of the opportunities for such service which are placed in our paths.

In the period remaining between the closing of this session and the International Engineering Congress, the members of the Society took part in a number of excursions to points of engineering interest, including the San Francisco High Pressure Fire System, the Portrero Gas Works, Station A of the Pacific Gas & Electric Co., the Spring Valley Water Works, the Great Western Power Company's Hydro-Electric Development on the Feather River, and dredging at Oroville, and the Spaulding-Drum Development of the Pacific Gas & Electric Company.

The International Engineering Congress opened its sessions on the morning of September 20. The proceedings of this Congress will be described in the next issue of The Journal.

The thanks of the Society are due to W. R. Cobleigh, who attended the September meeting, for the copy of the address by Prof. Durand sent to New York in time for publication in this issue, and to all others who contributed to the success of the September meeting.

CORRESPONDENCE DEPARTMENTS FOR THE JOURNAL

The Journal publishes from month to month papers given at the annual and spring meetings and at many meetings of the local sections of the Society. Discussion upon these papers, however, is not restricted to the meetings. In order to secure the greatest possible benefit from the knowledge and experience of the membership, the discussions given at the time the papers are presented must be supplemented by contributed discussions from those who were unable to be present when the papers were read.

Accordingly, the Publication Committee has authorized a correspondence department for discussions upon technical subjects relating either to papers that have already been presented to the Society, or to new matter, to which contributions are solicited. Comments on papers, brief accounts of new or original methods, and inquiries with regard to engineering problems may properly come within the scope of this department, which it is expected to make a permanent feature of The Journal.

In addition to a section devoted to technical discussion, it has further been decided by the Committee to inaugurate a section devoted to communications containing suggestions by the membership, of any kind or nature for increasing the usefulness of the Society to the community and to the individual. Brief letters for this department are also solicited in the belief that they will prove a helpful means for the guidance of the Society, in extending its activities among the membership.

THE ANNUAL MEETING

The Annual Meeting of the Society will be held in the Engineering Societies Building in New York from December 7 to 10 and even at the present early date the prospects are that the meeting will be one of the best in the history of the Society.

The Officers and Council especially urge members not resident in New York to come to the city if possible at the time of the Annual Meeting and take part in the deliberations.

Arrangements have been completed for sessions by the Sub-Committees on Railroads, Textiles and Protection of Industrial Workers, and for papers contributed by the Committees on Machine Shop Practice and Industrial Buildings, besides unclassified papers, many of unusual interest. In addition to the professional and business sessions and the President's reception, it is planned to hold a smoker.

REPORT OF THE NOMINATING COMMITTEE

As previously announced in The Journal, the Nominating Committee has reported the following names as candidates for the offices indicated:

For President:

D. S. JACOBUS, New York

For Vice-Presidents:

WM. B. JACKSON, Chicago, Ill.
J. SELLERS BANCROFT, Philadelphia, Pa.
JULIAN KENNEDY, Pittsburgh, Pa.

For Managers:

JOHN H. BARR, New York
JOHN A. STEVENS, Lowell, Mass.
H. de B. PARSONS, New York

For Treasurer:

WM. H. WILEY, New York

F. W. TAYLOR MEMORIAL MEETING

The Society to Promote the Science of Management issues a cordial invitation to all persons interested in scientific management and the work of the late Frederick W. Taylor to attend the special meeting to be held as a memorial to Mr. Taylor at 8.15 p. m. on Friday, October 22, in Houston Hall, University of Pennsylvania, Philadelphia, Pa. The program includes the following list of speakers several of whom were closely associated with Mr. Taylor in the vital periods of his career and important phases of his work: Rudolph Blankenburg, Mayor of Philadelphia; Carl G. Barth, Louis D. Brandeis, James M. Dodge, Edgar F. Smith, Provost of the University of Pennsylvania; Henry L. Gantt, Harlow S. Person and Sanford E. Thompson. Distinguished leaders of the scientific management movement in foreign countries have prepared appreciations which will be read.

The secretary of the society, Professor Henry W. Shelton, Hanover, N. H., will be glad to furnish information regarding this meeting to any members of the Society who desire it.

NAVAL ADVISORY BOARD

As announced in The Journal for August, the Society was honored by an invitation from the Secretary of the Navy, the Honorable Josephus Daniels, to participate in the work of the Naval Advisory Board, recently created with Thomas A. Edison, Hon. Mem. Am. Soc. M. E., as Chairman, by the appointment of two representatives on the board. In the endeavor to select for representatives men of foresight and executive ability in combination with inventive talent, a ballot of the Council has been taken, and the members to be thus honored are as follows: William Le Roy Emmet of the General Electric Company of Schenectady, N. Y., and Spencer Miller, of the Lidgerwood Manufacturing Company of New York City and member of the Council.

Invitations were extended to eleven engineering and scientific societies to be represented on the board, as follows: The Aeronautical Society of America, the American Chemical Society, the American Electrochemical Society, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, the American Mathematical Society, the American Society of Aeronautic Engineers, the American Society of Civil Engineers, The American Society of Mechanical Engineers, the Inventors' Guild, and the Society of Automobile Engineers. Two representatives have been chosen from each of these organizations with a view to obtaining the most advanced thought and experience in the various lines of engineering activity and scientific research.

Mr. Daniels has recently announced that the nominations of the eleven societies have been accepted, forming a board of 23 members including the chairman. The first general meeting of the board has been called for Wednesday, October 6th, at which the work will be organized and methods of procedure determined. The appointees are as follows:

Thomas A. Edison, Hon. Mem. Am. Soc. M. E., *Chairman*
Lawrence Addicks, Mem. Am. Soc. M. E.
L. H. Baekeland
Howard E. Coffin, Mem. Am. Soc. M. E.
Alfred Craven
William Le Roy Emmet, Mem. Am. Soc. M. E.
Peter Cooper Hewitt
A. M. Hunt, Mem. Am. Soc. M. E.
Benj. G. Lamme
Hudson Maxim
Spencer Miller, Mem. Am. Soc. M. E.
J. W. Richards
Andrew L. Riker, Mem. Am. Soc. M. E.
Thomas Robins
Wm. L. Saunders, Mem. Am. Soc. M. E.
Matthew B. Sellers
Elmer A. Sperry, Mem. Am. Soc. M. E.
Frank J. Sprague
Benj. B. Thayer
Arthur G. Webster
W. R. Whitney
Henry A. Wise Wood
R. S. Woodward

WILLIAM LE ROY EMMET

William Le Roy Emmet, one of the appointees of the Society, was born at Pelham, N. Y., July 10, 1859, son of William Jenkins and Julia Colt (Pierson) Emmet. He was educated at schools in Canada, New York, and Maryland, and subsequently entered the United States Naval Academy, where he was graduated in 1881. He served as a cadet midshipman until 1883 at Annapolis and on board U. S. S. Essex, and re-entered the navy as junior lieutenant in 1898, serving as navigator on the U. S. S. Justin during the period of the Spanish war. His principal civil employment has been with the Sprague Electric Railway and Motor Company, and the General Electric Co. He has achieved fame as an electrical engineer and as an inventor, and has obtained many patents for inventions in electricity, mechanics, and thermo-dynamics, most

of which have been incidental to his undertakings as an engineer. His most important electric work has been in the development of the general use of alternating current and in the invention and design of machinery to further the practical application of alternating current, while his most important mechanical work has been in connection with the development and introduction of the steam turbine. He designed and directed the development of the Curtis turbine by the General Electric Co., every detail of which was radically new, and which was carried on with a rapidity almost unprecedented in such undertakings. He designed the machinery for the first ships driven by electric motors, and was the first serious promotor of electric ship propulsion, conducting a series of experiments with the United States collier Jupiter which are destined to be epoch-making in the history of marine transportation. He is the inventor of several types of transformers, including an air-blast type which has been extensively used; of several types of insulation of alternators, and of other details of the design of alternators which have met with general acceptance. He is the original inventor of the oil switch, a device which is now almost universally used in large electrical work. The varnished cambric cable, which is widely used, is also an Emmet invention. He is the inventor of the vertical shaft steam turbine, of which a very large number have been built, and many details of turbine design in general use are to his credit. Mr. Emmet was responsible for most of the later and most successful and largest electric work of the Niagara Falls Power Co., also for the design and introduction of the Curtis steam turbine for electric uses. His achievements have been as a pioneer of new methods rather than as an inventor, and much of his most original and most useful work could not be effectively patented nor perhaps even classified as invention. Mr. Emmet is the author of "Alternating Current Wiring and Distribution" (1894). He is a member of the American Philosophical Society, American Institute of Electrical Engineers, The American Society of Mechanical Engineers and the Society of Naval Architects and Marine Engineers. He is also a member of the University and Engineers clubs of New York, of the Mohawk Golf, the Lobique, Salmon, Adirondack League, Mohawk and Schenectady Boat Clubs. He received the degree of D.Sc. from Union College in 1910.

SPENCER MILLER

Spencer Miller, the other appointee of the Society, was born at Waukegan, Ill., April 25, 1859, son of Samuel Fisher and Charlotte (Howe) Miller, of Worcester, Mass. He was graduated at the Worcester Polytechnic Institute in 1879, and after tutoring for a few months at Amherst College, entered the shops of the U. S. Wind Engine & Pump Co. of Batavia, Ill., where he remained for nearly a year. He then became a draftsman with the Link-Belt Machinery Co., Chicago, where he designed a number of rope drives, and a novel equipment for handling cargo by continuous systems of conveying for the Union Steamboat Company.

He made important improvements in rope driving with grooved pulleys of different diameters by varying the angle of the grooves. This invention was the subject of a paper entitled: "A Problem in Continuous Rope Driving," presented by him before the American Society of Civil Engineers in 1897. In 1886 he became associated with the Lidgerwood Manufacturing Co. of New York, which was then manufacturing a crude overhead cable system involving fall-rope carriers of the chain connected type, and he developed an entirely new fall-rope carrier system, the important part of the Lidgerwood cable-way of commerce. It was immediately adopted in various parts of the world for use in the construction of government fortifications, dams, filtration beds, sewers and similar work as in open mining. One of the stubborn engineering problems solved by Mr. Miller was the removal of cypress logs from Louisiana swamps, by means of a log-skidding cableway that reduced the cost of logs at the mill more than 50 per cent, and increased the capacity of the saw mills 400 per cent. One of the early problems of the Spanish-American war was presented to the Navy Department in the question of coaling ships at sea, and he designed a marine cableway that made it possible to tranship coal under headway at sea. In coaling ships in harbor his method of broadside handling has increased the capacity from 25 to 150 tons per hour, and one man now does the work which under the old system required eighty. Many new colliers of the U. S. Navy, notably the Jason, Orion and Neptune, are equipped with this transfer system, for delivering coal to ships alongside in smooth water. In 1914 he made the refueling of warships at sea the subject of a paper read before the Society of Naval Architects and Marine Engineers. One of the most revolutionary devices invented by Mr. Miller is his breeches buoy cableway apparatus in use by the U. S. revenue cutter service, by which passengers can be rescued from any ship in the heaviest sea.

Aside from his engineering activities, Mr. Miller is greatly interested in civic and municipal improvement, especially in the establishment of public libraries, parks and playgrounds in his home city, South Orange, N. J. He is a director of the South Orange Free Public Library and past president of the Playground Commission of South Orange. He is vice-president of the Essex County Mosquito Extermination Commission of New Jersey, and is the author of a paper entitled "Prevention of Mosquito Breeding," read before the American Society of Civil Engineers in 1912. He is a manager of The American Society of Mechanical Engineers; member of the American Society of Civil En-

gineers, American Institute of Mining Engineers, Society of Naval Architects and Marine Engineers, and the Canadian Institute of Mining Engineers. He is also a member of the Engineers Club, New York; Essex County Country Club, Orange, and the Metropolitan Club and University Club of Washington.

The representatives chosen from the other societies are as follows:

Aeronautical Society of America: Matthew Bacon Sellers of Baltimore, Md., and Hudson Maxim of Brooklyn, N. Y. Mr. Sellers is a graduate of the Lawrence Scientific School and is at present director of the Technical Board of the Aeronautical Society of America. He was the first to determine dynamic wind pressure on arched surfaces by means of "wind funnel." Mr. Maxim is an ordnance and explosive expert and maker of the first smokeless powder adopted by the United States Government.

American Chemical Society: W. R. Whitney of Schenectady, N. Y., and L. H. Baekeland of Yonkers, N. Y. Mr. Whitney is a graduate of Massachusetts Institute of Technology, '90. He is at present director of the Research Laboratory of the General Electric Company where he has been the moving spirit in the perfection of metallic electric lamp filaments and the development of wrought tungsten. Mr. Baekeland is a graduate of the University of Ghent, '82. He was the founder of the Nepera Chemical Company and inventor of photographic paper and bakelite. He is at present in private practice.

American Electrochemical Society: Joseph Williams Richards, of South Bethlehem, Pa., and Lawrence Addicks of Chrome, N. J. Mr. Richards is professor of electro chemistry at Lehigh University and is the author of numerous works on electro metallurgy. Mr. Addicks is a graduate of the Massachusetts Institute of Technology, '89, and a member of the Am. Soc. M. E. At the present time, he is consulting engineer for Phelps, Dodge & Co. and is an authority on the metallurgy of copper.

American Institute of Electrical Engineers: Frank J. Sprague of New York City and B. G. Lamme of Pittsburgh, Pa. Mr. Sprague is a graduate of the Naval Academy, '88, and now is consulting engineer for the Sprague, Otis and General Electric Companies. He was the founder of the Sprague Electric Railway Motor Company and was concerned in establishing the first electric trolley systems in the United States. Mr. Lamme is a graduate of the Ohio State University, '88, and is now chief engineer of the Westinghouse Electric and Manufacturing Company and a prolific inventor.

American Institute of Mining Engineers: William L. Saunders and Benjamin B. Thayer of New York City. Mr. Saunders is a graduate of the University of Pennsylvania, '86, and a member of the Am. Soc. M. E. He is chairman of the board of directors of the Ingersoll-Rand Company and inventor of many devices for subaqueous and rock drilling. Mr. Thayer is a graduate of Harvard University, '85. He is president of the Anaconda Copper Mining Company and an authority on explosives.

American Mathematical Society: Robert S. Woodward of Washington, D. C., and Arthur G. Webster of Worcester, Mass. Mr. Woodward is a graduate of the University of Michigan, '72. He is the president of the Carnegie Institution and an authority on astronomy, geography and mathematical physics. Mr. Webster is a graduate of Harvard, '85, and is a professor at Clark University. He is an authority on sound, its production and measurement.

American Society of Aeronautic Engineers: Henry A. Wise Wood and Elmer A. Sperry of New York City. Mr. Wood is engineer and manufacturer of printing machinery and student of aeronautics. Mr. Sperry is a graduate of Cornell, '76, and Mem. Am. Soc. M. E. He is the founder of the Sperry Electric Company and designer of electric appliances and gyroscopic stabilizer for ships and aeroplanes and the gyrocompass.

American Society of Civil Engineers: A. M. Hunt and Alfred Craven, both of New York City. Mr. Hunt is a graduate of the Naval Academy, '79, and a Mem. Am. Soc. M. E. He is a consulting engineer experienced in the development of hydroelectric, steam and gas plants. Mr. Craven is also a graduate of the Naval Academy, '67. He is chief engineer of the Public Service Commission and was formerly Division Engineer in charge of the construction work on the Croton Aqueduct and reservoirs.

Inventors' Guild: Peter C. Hewitt of New York City and Thomas Robins of Stamford, Conn. Mr. Hewitt is an inventor of electric lamp appliances to enable direct current apparatus to be used with alternating current circuits, and devices for telephones and aircraft. Mr. Robins is a graduate of Princeton. He is now president of the Robins Conveying Belt Company and inventor of many devices for conveying coal and ore.

Society of Automobile Engineers: Andrew L. Riker of Detroit, Mich., and Howard E. Coffin of Detroit, Mich. Both Mr. Coffin and Mr. Riker are members of the Society and past presidents of the Society of Automobile Engineers. Mr. Coffin is a graduate of the University of Michigan, '96. He is now vice-president of the Hudson Motor Car Company and active in the development of internal combustion engines. Mr. Riker is vice-president of the Locomobile Company. He is an electrical and mechanical engineer and inventor of many automobile devices.

YALE ENGINEERING ASSOCIATION

An organization has recently been formed among graduates from Yale University, to be known as Yale Engineering Association. Its purpose is to serve in an advisory capacity the engineering departments

of the University, to make recommendations regarding the courses, to furnish speakers on engineering topics for the undergraduates, to help young graduates in securing positions, to attack the problem of engineering education and to encourage Yale men to become affiliated with national societies. The executive committee has Edwin M. Herr, Mem. Am. Soc. M. E., as President, Harry N. Covell, Mem. Am. Soc. M. E., as Vice-President, and Richard T. Dana as Secretary-Treasurer. The first meeting of the association will be held in New Haven in the early part of November.

REPORT ON THE RESERVE CORPS OF CIVILIAN ENGINEERS

The suggestion was made last spring that the national engineering societies offer to assist the U. S. War Department in the formation of an engineer reserve in the United States Army. When brought to the attention of some of the officers of the Army, the suggestion was commended and they confirmed the belief that the need of such a reserve was a real one. The European War has distinctly shown that in time of war engineers of varied experience are required on a scale never before realized. In our own army no adequate provision is made for great numbers of engineers, for although the regular corps of engineers is composed of men of the very highest professional proficiency in certain lines, it is far short of the numerical strength that would be immediately required.

Acting on the suggestion for an engineer reserve, the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Consulting Engineers appointed committees authorized and directed to take such steps as might be advisable to urge the organization of such a reserve corps as part of the regular army, and so assist in putting the United States in a better condition of preparedness against war. Conferences were held with the Secretary of War and the officers of the General Staff and of the War College, and so much encouragement was received that it was felt advisable to form a single committee to represent jointly the five societies—in short, the engineering profession as a whole. This will simplify future conferences with those in authority and show that the various engineering organizations are earnestly coöperating.

After obtaining formal permission from the five societies, a joint committee has now been formed, consisting of the chairmen of the previously appointed society committees, as follows:

Wm. Barclay Parsons, *chairman Committee, American Society of Civil Engineers,*

Henry S. Drinker, *chairman Committee, American Institute of Mining Engineers,*

William H. Wiley, *chairman Committee, American Society of Mechanical Engineers,*

Bion J. Arnold, *chairman Committee, American Institute of Electrical Engineers,*

Ralph D. Mershon, *chairman Committee, American Institute of Consulting Engineers.*

This committee has selected Mr. Parsons as chairman and is in communication with the War Department.

Before a reserve corps can be formed, legislation authorizing it must be passed by Congress and approved by the President. The details of such legislation are now being studied by the War Department. While no decision has been reached, it is under consideration to issue commissions as officers to such engineers as will meet certain professional and physical standards. These officers would, in times of necessity, be subject to orders from the Secretary of War as officers of the army, and at other times they would perform such duty as would not seriously interfere with their ordinary work, but would give each officer some military education and experience. In this way it is hoped to have a large body of engineers which could be called quickly to duty.

The separate committees are still in existence to do the necessary work among their fellow members of the several societies as soon as the decision of the War Department is given and a general scheme of organization is adopted.

WM. BARCLAY PARSONS, *Chairman,*
HENRY S. DRINKER,
WILLIAM H. WILEY,
BION J. ARNOLD,
RALPH D. MERSHON.
Joint Committee of the National Engineering Societies on the National Reserve Corps of Engineers.

August 28, 1915.

INTERNATIONAL GAS CONGRESS

The International Gas Congress, under the auspices of the American Gas Institute, was held in San Francisco during the week of September 27th. The Congress opened with the annual meeting of the Pacific Coast Gas Association and a reception to the President of the American Gas Institute, Dr. Alex C. Humphreys, Mem. Am. Soc. M. E. The following day the professional sessions of the Congress were commenced and the annual meeting of the American Gas Institute took place. Symposiums on illumination, commercial aspects of the gas business and modern coal gas processes and of present British practices in the manufacture of coal gas were held during the week. President C. C. Moore of the Panama-Pacific International Exposition presented the Congress with a bronze medal. A number of entertainment features were provided and a visit was paid to the gas exhibits at the Exposition. The Congress closes on October 2.

APPLICATIONS FOR MEMBERSHIP

TO BE VOTED FOR ON NOVEMBER 10, 1915

Members are requested to scrutinize with the utmost care the following list of candidates who have filed applications for membership in the Society. These are sub-divided according to the grades for which their ages would qualify them and not with regard to professional qualifications, i. e., the ages of those under the first heading would place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, while those in the third class are qualified for Junior Grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into the Membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote. These candidates will be balloted upon by the Council unless objection is received by November 10, 1915.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

ALEXANDER, JOHN S., Dist. Mgr., Diamond Pwr. Specialty Co., Philadelphia., Pa.

ANDERSON, ANDREW F., Instructor in Shopwork, Schools of the City of New York.

BEAGHEN, THOMAS, JR., Master Car Builder, Union Tank Line Co., New York.

BIGGERT, FLORENCE C., JR., Ch. Engr., United Engrg. & Fdy. Co., Pittsburgh, Pa.

BRIDGES, LUTHER W., Mech. Engr., with Chas. H. Tenney & Co., Boston, Mass.

BUERGER, CHARLES B., Cons. Engr., Atlantic Refining Co., Philadelphia, Pa.

CANDA, CHARLES A., Secy., Chrome Steel Wks., Chrome, N. J.

CHATILLON, RALPH F., Vice-Pres., John Chatillon & Sons, New York.

CLARK, ALBERT B., Efficieney Engr., Commonwealth Edison Co., Chicago, Ill.

DAWSON, GEORGE H., Engr.-in-charge of Equip., Remington Arms & Ammunition Co., Ilion, N. Y.

DISSEL, THEODORE A., Mgr., Cameron Appliance Co., Everett, Mass.

EDMONDSON, RALPH S., Engr., Amer. Abrasive Metals Co., New York.

EGLIN, WILLIAM C. L., 2nd Vice-Pres., and Ch. Engr., The Philadelphia Elec. Co., Philadelphia, Pa.

ENKE, GEORGE P., Insurance Engr., Goffe & Little, New York.

FEELEY, FRANK G., Mgr., Chicago Branch, M. D. Knowlton Co., Chicago, Ill.

FELL, HUGH P., Mech. Div. Ch., Elec. Bond & Share Co., New York.

FENN, ROBERT H., Engr. and Pur. Agt., Kent Mill Co., Brooklyn, N. Y.

FERGUSON, HUGH M., Mech. Engr., Missoula Light & Water Co., Missoula, Mont.

FRALICH, JOHN S. Y., Asst. Res. Engr., The Westinghouse Air Brake Co., Chicago, Ill.

GALE, WALTER L., Engr. and Tool Designer, Hopkins & Allen Arms Co., Norwich, Conn.

GENTLES, FRANK, formerly Ch. Engr., Cathedral Corp., Garden City, L. I., N. Y.

GILLIAM, THOMAS B., Engr. of Tests, Island Creek Coal Sales Co., Cincinnati, Ohio.

HATFIELD, ROBERT L., Prop., Hatfield & Co., Newark, N. J.

HENDRY, WILLIAM S., Instructor in Mech. Arts, Univ. of Arizona, Tucson, Ariz.

HERR, BENJAMIN M., Combus. Engr., Stoker Dept., The Westinghouse Elec. & Mfg. Co., Chicago, Ill.

HOBSON, RUSSELL B., Inventor, New Brighton, N. Y.

HULL, JOHN D., Private business, engaged in mechanical construction, Seattle, Wash.

HUNT, HARRY V., Supt., The Hooven, Owens, Rentschler Co., Hamilton, Ohio.

JEGGE, EMIL G., Mech. Engr., Arlington Co., Arlington, N. J.

JERAULD, WILLIAM E., Genl. Supt., Amer. Steam Gauge & Valve Mfg. Co., Boston, Mass.

JOHNSON, JOSIAH F., Asst. Engr., Turbine Dept., The Westinghouse Mch. Co., E. Pittsburgh, Pa.

JONES, RICHARD E., Supt. Automatic Feeding Mch. Dept., Dexter Folder Co., Pearl River, N. Y.

KISTNER, HERMAN, Prod. Engr., Otis Elev. Co., Harrison, N. J.

KLOCK, ERNEST L., Supt., New Niguero Sugar Co., New York.

KOCH, FELIX, Mech. Engr., Pressed Steel Car Co., Pittsburgh, Pa.

LAUBENSTEIN, A. R., Mgr. and Treas., Laubenstein Mfg. Co., Ashland, Pa.

LUND, HUGO, Ch. Draftsman, Metropolitan Street Rwy. Co., Kansas City, Mo.

LYND, ROY E., Asst. Supt., Richardson & Boynton Co., Dover, N. J.

MCCALLUM, JAMES R., Designer, The Crown Cork & Seal Co., New York.

MERRICK, DWIGHT V., Cons. Engr., New York.

MERRITT, LOUIS G., Pres., Merritt Mfg. Co., Lockport, N. Y.

MICHAELIS, GEORGE V. S., Secy., Bell Products Co., Springfield, Mass.

MITTENDORF, WILLIAM, Asst. Ch. Engr., The Cincinnati Traction Co., Cincinnati, Ohio.

MURRAY, WILLIAM E., Ch. of Steam Boiler Insp. Dept., City of Seattle, Wash.

NEEFUS, HAROLD V. H., Mech. Engr., The Texas Company, New York.

NOLAN, M. WILLIAM, Mech. Engr., Dept. of Steam Engrg., Cambria Steel Co., Johnstown, Pa.

PERSONS, J. O., Asst. Shop Supt. and Mine Prod. Expert, Navy Yard, Norfolk, Va.

PRICE, JOHN B., Engr. in Charge of Motor Dept., Ilg Elec. Ventilating Co., Chicago, Ill.

QUINLIVAN, OSWALD, Mech. Engr., U. S. Engr. Office, Albany, N. Y.

RAYMOND, CYRUS F., Indus. Engr., The B. F. Goodrich Co., Akron, Ohio.

REID, ARTHUR, Commr. of Pub. Utilities, Corp. of City of Lethbridge, Alberta, Canada.

SCHLEYER, VICTOR, Designing Engr., American Well Wks., Aurora, Ill.

SCOVELL, CLINTON H., Indus. Engr., Clinton H. Scovell & Co., Boston, Mass.

SMITH, ABRAM E., Asst. Master Car Builder, Union Tank Line Co., New York.

TRYON, CLARENCE A., Engr., Internatl. Acheson Graphite Co., Niagara Falls, N. Y.

WALKER, LEE E., with Good Roads Mchy. Co., Philadelphia, Pa.

WALTHER, ARTHUR C., Engr. and Supt. of Constr., Nixon Nitration Wks., New Brunswick, N. J.

WILSON, AMYUIT L., Boiler House Efficieney Engr., Spreckles Sugar Refining Co., Philadelphia, Pa.

WILSON, JONATHAN A., Traveling Engr., Babcock & Wilcox Co., Bayonne, N. J.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

BARKER, ERNEST S., Engr.-in-charge, Chas. H. Scammell Co., Factory, West New York, N. J.

BINGAMAN, RALPH W., Engr., Communipaw Steel Co., New York.

BRADY, GEORGE S., Efficieney Engr., Winchester Repeating Arms Co., New Haven, Conn.

BRENNAN, EDWARD M., Junior Mech. Engr., Div. of Valuation, Interstate Commerce Comm., Chattanooga, Tenn.

CADY, HARRISON R., Asst. Mech. Engr., Bureau of Water Supply, Philadelphia, Pa.

GOODSPEED, CHARLES B., Vice-Pres., The Buckeye Steel Castings Co., Chicago, Ill.

KELLER, GEORGE M., Prod. Supvr., General Motors Truck Co., Pontiac, Mich.

KIEFER, PAUL J., Instr. in Mech. Engrg., Univ. of Penn., Philadelphia, Pa.

KNAPP, WALTER, Shop Supt., Lea-Courtney Co., Newark, N. J.

LEWIS, GOODRICH Q., Mech. Engr., as Asst. to Mech. Supt., with W. H. Miner, Chicago, Ill.

MCCURDY, ALEXANDER D., Partner, McCurdy & Boyer, Philadelphia, Pa.

MCLAREN, LEWIS L., Steam Engr., Wisconsin Steel Co., So. Chicago, Ill.

MORSE, WALTER R., Asst. Supt., The Shoe Hardware Co., Waterbury, Conn.

NELSON, JOHN E., Draftsman, De Laval Separator Co., Poughkeepsie, N. Y.

PERHAM, DEANE E., with The Automatic Refrigerating Co., Hartford, Conn.

POWELL, PAUL R., Designing Draftsman, The Crown Cork & Seal Co., Baltimore, Md.

RIEDL, ALBERT F., Efficieney Engr., Geuder, Paeschke & Frey Co., Milwaukee, Wis.

STICKSEL, C. P., Mech. Engr. or Mas. Mech., The Globe Soap Co., St. Bernard, Ohio.

TYSON, JAMES S. Y., Engr., Mexican Petroleum Corp., Carteret, N. J.

WALSH, FRANK J., Mech. Expert, Galena-Signal Oil Co., Chicago, Ill.

WELCH, JAMES B., Asst. Shop Supt., Indus. Dept., United States Navy Yard, Norfolk, Va.

FOR CONSIDERATION AS JUNIOR

ADAMS, CARROLL E., Draftsman, Jenks & Ballou, Cons. Engrs., Providence, R. I.

BARNABY, RALPH S., Insptr. of Material, The Elco Co., Bayonne, N. J.

BODENSTEIN, WILLIAM E., Mech. Engr., Stegner & Hughes, Arch. & Engrs., Newport, Ky.

COMFORT, NEWMAN, Mgr., Univ. Inspection Co. of Ia., Nebr. Div., Omaha, Neb.

DICKSON, CHARLES H., JR., Engrg. Dept., Natl. Sugar Refining Co. of N. J., Long Island City, N. Y.

FREEMAN, BENJAMIN W., Mgr., The Benjamin W. Freeman Co., St. Louis, Mo.

GEST, ALEX. P., JR., Mech. Engr., Chem. Dept., Barrett Mfg. Co., Philadelphia, Pa.

HILL, FRANCIS L., Draftsman, Covington Mch. Co., Covington, Va.

HOFFMANN, JOHN E., Mech. Engr., Testing Dept., Pencoyd Iron Wks., Amer. Bridge Co., Pencoyd, Pa.

KEHL, ROBERT J., Junior Engr., Oxweld Acetylene Co., Chicago, Ill.

LACAZETTE, ALFRED A., Engrg., West India Oil Co., New York.

MATHEWSON, JAMES S., Instr. in Engrg., Univ. of Akron, Akron, Ohio.

MAYNZ, THEODORE, Engr., Combustion Engrg. Corp., New York.

NEAGLE, RUSSELL J., with Boston Edison Elec. Ill. Co., Boston, Mass.

PALMER, BRIAN C., Mech. Engr., Amer. Taximeter Co., New York.

PRATT, LEWIS W., Safety Inspector, Aetna Life Ins. Co., Bureau of Insp. and Accident Prevention, Hartford, Conn.

PRIEBE, ERNEST B., Erecting Engr., Amer. Engrg. Co., Philadelphia, Pa.

SAUSEN, BERT R., Mech. Engr., Schutte & Koerting Co., Philadelphia, Pa.

SAVEDOFF, MORRIS M., Insp. Dept., New England Westinghouse Co., Chicopee Falls, Mass.

VINE, HOWARD L., Mech. Draftsman, The Reeves Bros. Co., Alliance, Ohio.

WALLNER, EDWARD P., with Nordyke & Marmon Co., Indianapolis, Ind.

ZABRISKIE, WILLIAM H., Standard Oil Co. of New York, Long Island City, N. Y.

ZUGELTER, GEORGE E., Engrg. Dept., The Lunkenheimer Co., Cincinnati, Ohio.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

COUTANT, JAY G., Engr., Railway Materials Co., Chicago, Ill.

PROMOTION FROM JUNIOR

BLAKE, RAYMOND P., Efficieney Engr., Dodge Bros., Detroit, Mich.

JENNINGS, IRVING C., Vice-Pres., Nash Engrg. Co., So. Norwalk, Conn.

MURPHY, THOMAS R. H., Indus. Engr., Jos. H. Wallace & Co., New York.

RICKCORD, REGINALD V., Instr., Dept. of Public Instruction, Rochester, N. Y.

SYMONDS, NATHANIEL G., Mgr. Prime Mover Div., Westinghouse Elec. & Mfg. Co., Chicago, Ill.

TUTTLE, IRVING E., Pwr. Plant Engr., Baker, Smith & Co., New York.

SUMMARY

New applications	103
Applications for change of grading:	
Promotion from Associate-Member	1
Promotion from Junior	6
	110

SAN FRANCISCO MEETING

THE Panama-Pacific International Exposition, held this year at San Francisco, and the notable engineering event exemplified in the International Engineering Congress, were the occasion of the special meeting of the Society on September 16 and 17, which is the first mid-year meeting held by the Society since the early years of its organization. Advantage was taken of this unusual opportunity to deal with subjects of local interest. Two of the papers were devoted to engineering at the Exposition and two others to the oil engine in relation to power production on the Pacific slope. A fifth paper dealt with an investigation upon the Strength of Gear Teeth made at Leland Stanford Junior University, California. The two papers upon the Exposition are published in this issue practically in full, while the remaining three will be given in the next number of The Journal.

ENGINEERING FEATURES OF THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

BY GUY L. BAYLEY, SAN FRANCISCO, CAL.

Member of the Society

An exposition is a modern city built to order and as such must be provided with every utility and convenience with which the public is familiar. Even though the existence of the exposition be short, none of these may be omitted or restricted. In the planning and construction of such a project all branches of engineering play a part and, while there are many details which require special treatment, the real engineering problem lies in the modifying of standard practice to secure the temporary service desired at the lowest possible cost, with the use of such material as will facilitate the final dismantling of the exposition and the realization of a high salvage value.

The organization of the engineering departments of the Panama-Pacific International Exposition, the layout of the grounds, the design and construction of the buildings, and the operation of the service facilities have proven an engineering undertaking of the greatest magnitude. Mr. Bayley has pointed out in his paper many unusual features of the great undertaking which will be of absorbing interest to engineers. Attention is called to the extensive use of timber construction for the buildings, which introduced unusual constructive problems. The provisions for power, water supply, fire protection, sanitation, etc., are discussed in considerable detail, and further information upon these important features is to be filed by the author in the Library of the United Engineering Society for permanent reference.

HYDRAULIC FILLS

At the time the Exposition took possession of its site, that portion of the grounds to be occupied by the main buildings (about 70 acres) was under 12 ft. of water at mean high tide, and it was necessary to fill this section and, in addition, the low lands within the Presidio (a U. S. Military reesrvation). The filling was done by suction dredges which operated off-shore a distance of about 300 ft. in depths of from 30 to 50 ft. The discharge carried 8 per cent to 10 per cent of solid matter which ran 60 per cent to 70 per cent sand, the balance being sea mud and silt. The dredged material was handled so that it displaced about 5 ft. of soft ooze which existed in the bottom of the basin, the ooze being dissolved and carried out through the waste gates. In order to expedite the work of removing the soft portions of the original bottom, water instead of a mixture was pumped at intervals. To reclaim this portion of the site required the pumping of 1,300,000 cu. yd. of material at a cost of $218,000.

Shortly after the fill had been completed, settlement stakes were driven and readings taken to establish the rate of settlement, which was rapid at the start and decreased shortly to a slow but uniform rate. After the initial settlement had taken place borings were made at the sites of all buildings of the main group to determine the character of the underlying material and depth of hardpan. Test piles were driven to ascertain the supporting value of the ground at various depths. These tests showed that the dredger fill not only had no supporting value, but actually produced a load on the piles driven through it, tending to drag the piles down at the speed of its own settlement. As the result of a large number of tests, it was decided not to depend upon the thin strata of blue mud and clay underlying the dredger fill, but to drive the piles to a penetration of 1 in. to the blow of a No. 1 Vulcan steam hammer in the hard layer of green sand and clay overlying the hardpan.

In the areas not affected by the dredger fill, there was a layer of overlying soft clay, and tests showed that short piles terminating in the sand offered practically as much resistance as those driven through the sand into the clay. The sand had a supporting value of 3000 lb. per sq. ft. and spread footings were considered, but it was found that short piles averaging 14 ft. provided a cheaper and simpler construction. It was also thought that the adoption of pile footings would offer greater resistance in case of earthquake, previous experience having indicated that structures were most affected when resting on filled ground by means of spread footings.

The decision not to drive into the substratum of soft clay resulted in a great saving. The results of these tests were of

Presented at the Panama-Pacific International Exposition Meeting of the Society, San Francisco, September 1915. The paper may be obtained in pamphlet form; 25 cents to members, 50 cents to non-members.

the greatest value as they provided definite data for the design of foundations. The information gained was furnished to bidders and naturally resulted in lower prices, as contractors were able to know the lengths of piling required and thus avoid unnecessary waste. The total number of piles driven was 15,654 and the linear feet 645,692. The average cost was 24½ cents per lin. ft. below cut-off, and the average length of pile 41.2 ft.

The dredger fill in the Presidio was shallow, not exceeding 6 ft. at any point. The total amount pumped was 400,000 cu. yd. which reclaimed 114 acres of land at a cost of $84,000. The buildings in this area are light frame structures and as a rule rest on spread footings.

STRUCTURAL DESIGN

With the exception of the frames of the Tower of Jewels and the Palace of Fine Arts and the dome of the Palace of Horticulture, the buildings are timber structures. All the buildings, except Festival Hall, have pile foundations for the framework. The floor sub-structures of those buildings located on the dredger fill have pile foundations and the others spread footings or mud sills, depending upon the nature of the ground. The pile foundations for the Tower of Jewels are capped with reinforced concrete. Prior to the decision on the type of foundations to be used in each instance, tests were made of the ground on which the buildings were to be erected. These tests gave accurate data as to the length of piles required and the allowable loading. The piles varied from 13 to 75 ft. in length, although a few 120 ft. long were required under the Transportation Building. The safe carrying capacity of one pile was found to be 20 tons.

From an engineering viewpoint, the Tower of Jewels is probably the most interesting structure on the grounds. It is 435 ft. high and 120 ft. square in plan from the ground level to elevation 152 ft., from which level to elevation 335 ft. it takes the form of a truncated pyramid. From elevation 335 ft. to 364 ft., the frame is made up of four vertical columns 20 ft. apart and braced with rods. Above this elevation the frame forms a tower 8 ft. by 8 ft. in plan to elevation 397 ft., from which point runs a central post which supports a ball 17 ft. in diameter. The framing of the tower required 1403 tons of structural steel.

The glass dome of the Palace of Horticulture has an extreme height of 185 ft. and is 152 ft. in diameter. The upper portion has the form of a half sphere, while the lower portion is cylindrical. The supporting frame of the dome was figured as a true dome and consists of 24 steel ribs tied together by 11 horizontal rings. The dome and cylinder are carried on plate girders and trusses which in turn are supported by 8 structural piers 65 ft. in height.

FIG. 1 PANAMA-PACIFIC INTERNATIONAL EXPOSITION, 1915

The framing of the dome of Festival Hall presented many difficulties, owing to the size of the dome and the large arched openings on two sides. The curved dome was built on a supporting pyramidal dome 140 ft. in diameter with 16 trussed ribs. This dome was carried by 4 main piers and by 8 columns. The ribs occurring over the arched openings were carried by two trusses of 77-ft. span. The pyramidal dome was designed as a true dome, the ring tension at the supports being cared for by two 3⅛-in. rods. The dome roof with a diameter of 172 ft. was built of sheathing supported by 2-in. by 6-in. rafters resting on studded walls which were carried by beams spanning the main ribs. The exterior ceiling was suspended from the dome ribs.

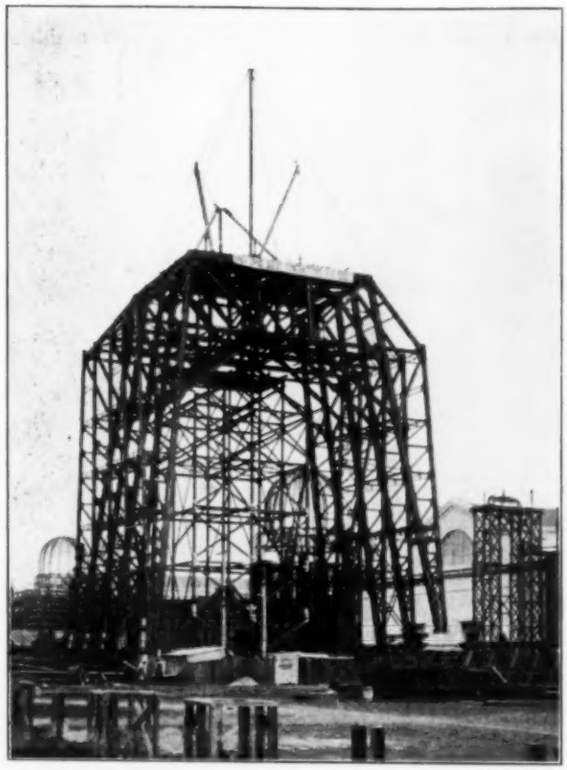


Fig. 2 Steel Frame of Tower of Jewels to Elevation 152 Ft.

Fig. 3 Completed Steel Frame, Tower of Jewels

Fig. 4 Timber Frame over Steel Frame, Tower of Jewels

Fig. 5 Tower of Jewels, Plaster Work Being Applied

For a frame structure the Palace of Machinery claims attention on account of its size—968 ft. by 368 ft., with a height of 136 ft. in the transverse bays and 120 ft. in the longitudinal bays. The spans of the longitudinal and transverse bays are 75 ft. The arched trusses give the building an attractive appearance and the framing is of interest, particularly at the intersections of the longitudinal and transverse bays. The columns of the longitudinal bays were designed to support traveling cranes carrying loads up to 30 tons.

Owing to fire protection requirements, the frame of the Palace of Fine Arts was built of steel. The building is curved in plan, 950 ft. long and 135 ft. wide. Three hinged arches were used for this building, the span being 131 ft. and the height from the floor to the center hinge 48 ft. Steel channels placed beneath the floor served as ties for the lower hinges. Light bracing trusses were used to connect the arches and form supports for the purlins. The roof and walls were constructed with cement-plaster on metal fabric, the roof with a thickness of 3 in. and the walls 2½ in.

The Auditorium, located in the Civic Center, was built at an expense of over $1,000,000, and is a permanent fireproof structure of four stories, occupying a city block 200 ft. by 187 ft. The main hall has a seating capacity of 10,650, and there are 10 halls or large rooms for conventions. Flanking the main hall on each side and extending the height of two stories are banquet rooms, 56 ft. by 136 ft. The only feature of the building that is unusual is the dome, which may be described as a truncated octagonal pyramid with a maximum diameter of 205 ft. 6 in. and a height of 40 ft. The height of the spring line of the dome from the floor is 79 ft. The dome framework is of interest, not only on account of its great diameter, but also from the fact that it was designed as a true dome. The eight main trussed-ribs are 6 ft. deep at the upper end and 10 ft. at the lower, and are carried by eight columns. The horizontal thrust at the bottom is taken up by four 1⅞-in. by 6-in. eyebars. The supporting columns are connected by trusses having a depth of 14 ft.

There are no unusual features in the structural design of the eight buildings which form the main group, although the framing of the domes and half domes were interesting problems on account of the use of timber where steel would have been used in ordinary practice. The domes are 100 ft. in diameter and 162 ft. high, each with 32 ribs resting on a circular girder which in turn is supported by four girders with connecting diagonals at the corners, thus providing eight points of support for the ring. Half domes, 112 ft. high and 72 ft. wide, form the entrances to the Palaces of Food Products and Education and are constructed of double, 3-hinged timber arches for carrying the walls and arched roof, and a steel 3-hinged arch for carrying the trussed ribs. The construction of the walls is quite different from that employed at previous expositions in that a single line of 2-in. by 6-in. studs, 18-in. centers, are used with horizontal girders every 13 ft., instead of the usual double line of studs laced together. The floors in these buildings, as elsewhere, are constructed of 2-in. shiplap. Where spread footings were used, the floor was laid on 2-in. by 8-in. joists, 2-ft. centers with 9-ft. spans, supported by 6-in. by 8-in. girders with 9-ft. spans, while with pile footings 2-in. by 12-in. joists are used 2-ft. centers, 14-ft. spans, with 10-in. by 16-in. girders, 20-ft. spans.

The brevity with which this phase of the work has been treated is no index to its importance, as the making of the structural designs formed a large part of the engineering work. Necessarily, once the elements of a design had been worked out, there was much duplication, but a great deal of skill and originality were shown in applying to timber framing much of the knowledge which has been acquired in recent years relative to steel frame structures.

At the start rules were made governing all structural work in which the allowable loads, stresses and other designing data were established, with the result that the designs were consistent throughout. Some idea of the volume of work handled by the structural bureau may be gained from the number of drawings made, there being 781 sheets covering an area of 13,277 sq. ft., from which 27,355 prints were made. When the work was at its height 70 structural draftsmen were employed by the structural bureau.

SEWER SYSTEM

Use was made of a number of city sewers which crossed the site, one of which was large enough to be used as the main outfall for all sanitary sewage. A separate system was installed for storm water, with frequent connections to the Bay. The plan of using separate sewers was adopted as it was permissible to place the storm sewer near the surface and use a cheap form of construction. The amount of storm water to be cared for was figured from the San Francisco rainfall rate curve, which gives a rate of 2.16 in. per hour for a 5-min. interval and a rate of 0.598 in. for a 60-min. interval. The handling of the sanitary sewage in the low area within the Presidio necessitated a pumping plant, which was located near the center of the district and discharged into the main outfall through 1170 ft. of 20-in. wood stave pipe.

The sewer system was simple and direct and was based on the use of second quality vitrified pipe in sizes from 8-in. to 15-in. and banded wood stave pipe for sizes up to 30-in., except that in the States and Foreign sites, where watertightness was a requirement, wood stave pipe as small as 10-in. was used. The sewer system, including catch basins, cost $142,000, and comprised some 28 miles of pipe.

TRANSPORTATION

The handling of building material and exhibits proved to be one of the largest tasks in the construction of the Exposition.

Owing to the location of the Exposition along the shore of the Bay of San Francisco, it was possible to unload the lumber, which formed the bulk of the material to be handled, direct from vessels to the Exposition's wharves. The principal problem was to get the lumber away from the wharves which provided little or no storage, and the plan adopted was to use 2-wheeled lumber trucks, upon which the lumber was landed by ship's tackle. Single horses were used to drag the trucks, the driver guiding the truck by hand.

The unloading rate per vessel reached 30,000 ft. per hour at times, and to care for this quantity of lumber required some 200 trucks, 68 horses and 140 men.

Plank roads were laid around the four sides of each building site and over these the lumber was hauled to the adjacent storage space. The lumber was so ordered that an entire cargo would be for one designated building, and there was, therefore, no necessity for sorting on the wharf. The work of receiving, hauling and rough-piling the lumber was let to

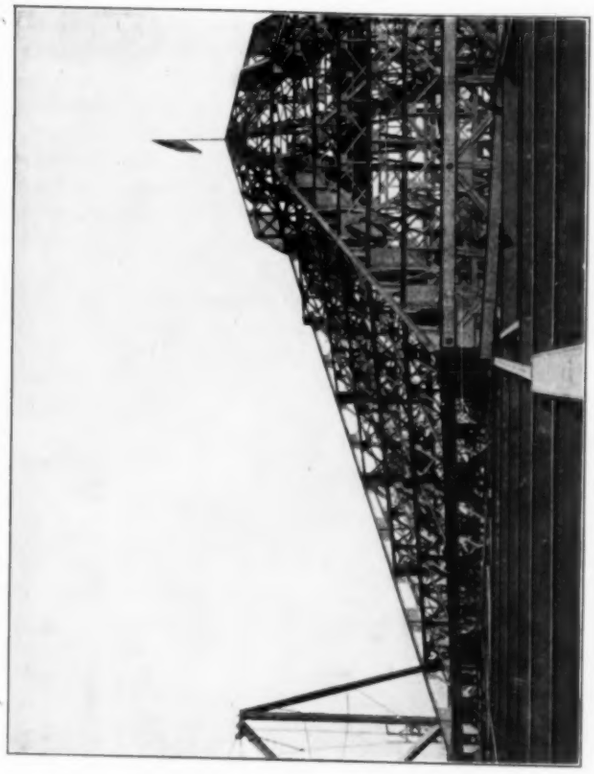


FIG. 7 DOME OF AUDITORIUM

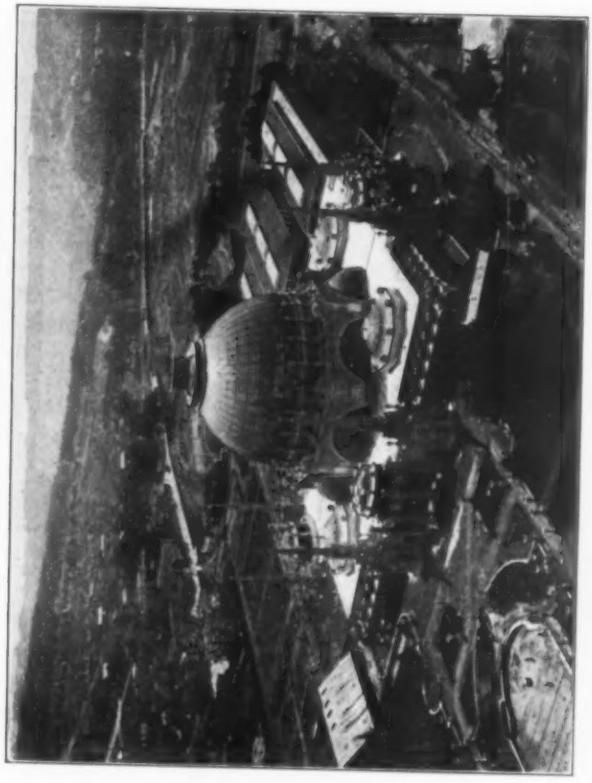


FIG. 9 COMPLETED DOME OF PALACE OF HORTICULTURE

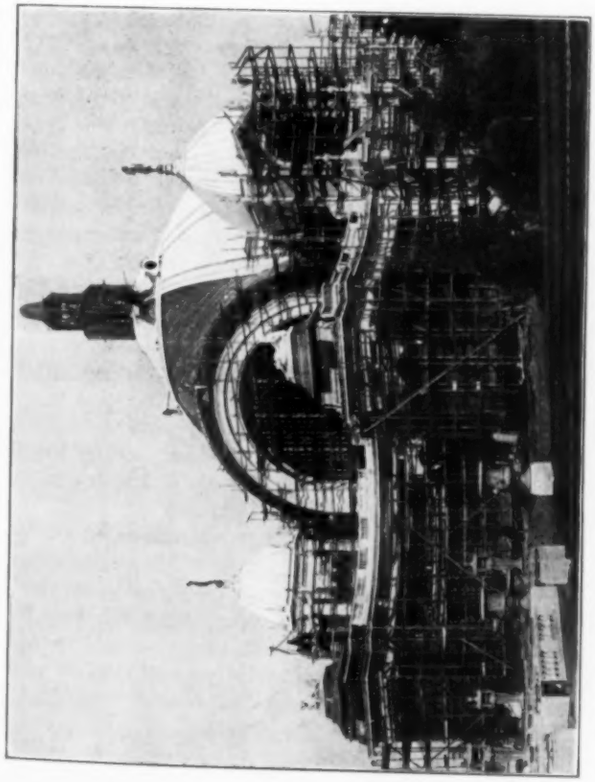


FIG. 6 FESTIVAL HALL PARTIALLY COMPLETED

FIG. 8 DOME AND ARCHED OPENING, FESTIVAL HALL

contract at prices varying from 35 cents per 1000 ft. for short hauls to $1.10 per 1000 ft. for long hauls. The total amount of lumber handled under contract was 68,131,000 ft. and the amount paid to the contractor for this work was $68,000. The plank roads referred to consisted of 3-in. planks 16 ft. long laid on 3-in. sills, and were laid by the Exposition's forces, approximately 1,950,000 ft. of lumber being used for this purpose alone.

In addition to the amount of lumber unloaded by contract there was handled over the wharves, in the manner described, about 9,500,000 ft. of lumber. The balance of the lumber used by the Exposition and its participants was purchased locally and delivered by teams and wagons, and amounted to about 32,000,000 ft.

Building materials other than lumber have been estimated as being about 800,000 tons. To handle these enormous quantities of materials expeditiously and without confusion required careful planning of temporary roadways and the systematic routing of traffic.

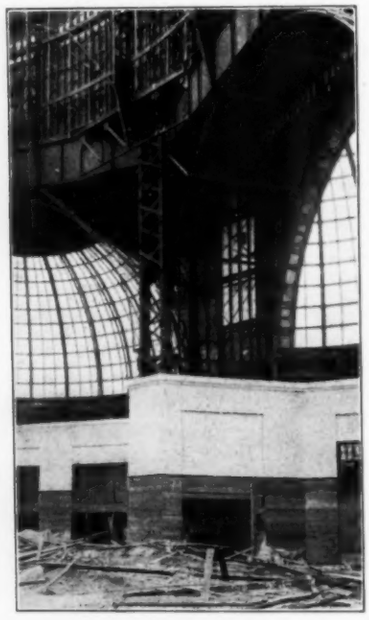


FIG. 10 CONNECTION OF PILES TO GIRDERS, PALACE OF HORTICULTURE DOME

The Exposition Terminal Railway was built primarily for handling exhibits, but was used to advantage during the construction period for distributing 36,000 tons of construction material and 5,000 tons of general freight received on cars. This road was built by the Exposition's forces and included 11½ miles of standard track, 3½ miles of which was laid within the exhibit buildings for unloading direct from the cars to the exhibitors' spaces. A spur track was run to the U. S. Transport Dock so that freight from ocean-going vessels could be loaded on the Exposition's cars. Cars from the various transcontinental lines were brought to the grounds on barges, for the accommodation of which the Exposition built a freight slip.

The design of this slip follows the standard practice of the San Francisco Bay district in that the bridge forms a span between the boat and the shore. The bridge is hinged on the shore end, while the outboard end is suspended by cables which pass over sheaves to suitable counterweights. The counterweights are sufficient to overbalance the weight of the bridge and eliminate danger of dropping the bridge into the bay. To lower the bridge that portion of the counterweights required for overbalancing is raised by hydraulic means and the bridge is allowed to land on the shelf or recess provided in the bow of the barge. In operation, the live load on the bridge is divided between the boat and the shore supports, and the gallows frame carries only the weight of the bridge and counterweights—about 400,000 lb.

FIG. 11 STEEL DOME OF PALACE OF HORTICULTURE

The hydraulic equipment consists of a vertical cylinder 28 in. in diameter and 12 ft. long, a motor-driven triplex pump and an accumulator. Cables run from the crosshead on the piston rod to the two auxiliary counterweights which rest on the main counterweights when the bridge is in the raised position. The water supply to the cylinder is controlled by a piston type valve fitted with cup leathers. This valve is operated by hand, but in case of overtravel of the bridge is automatically closed. The accumulator controls the motor operating the pump so as to maintain a constant pressure of 90 lb. per sq. in.

A 20-ton locomotive crane with a 35-ft. boom and grab bucket was secured at an early date, and, in addition to its use for unloading road material from cars, spotting cars and similar work, was found most useful for unloading heavy boxed trees and the erection of standards and statuary, an extension boom being used in many instances.

The work of the electrical department was expedited by the use of a 1-ton storage battery crane truck having a 2-ton trailer. While adapted for general delivery work, the greatest value of this was realized in transporting transformers and oil drums from the warehouse to the numerous building vaults. The transformers were loaded on to the trailer and hauled to a point opposite the vault, where they were lifted off the trailer one at a time and landed on dolly trucks. Planks were laid from the curb up the steep terraces and into the vaults, over which the dolly trucks were hauled by a

rope running around a block inside the vault and fastened to the back of the truck. Transformers up to 50 kw. in size were handled in this fashion with surprising ease and speed. After building an extension to the boom, the crane was used for setting gas and incandescent standards. No other type of equipment proved as useful as the battery truck crane for handling loads not exceeding one ton.

As the Exposition had undertaken to deliver all exhibits from the cars to the designated space, and as it was known from past experience that most of the exhibits would arrive in the 60-day period prior to the opening, this problem called for careful consideration. Transveyors consisting of 4-wheeled hand trucks for use in connection with special detached platforms were adopted for this service. The freight was loaded on the platforms which were later picked up by the transveyors and transported to the exhibit space.

Storage battery industrial trucks were also used for handling exhibits, a type being adopted which had an extension platform suitable for handling bulky goods. These trucks had a capacity of 2 tons each and frequently towed several transveyors in addition to carrying a full load. Motor cars and trucks have played no small part in the construction of the Exposition, in that they have enabled men and materials to be moved rapidly when and where required. With work scattered over a territory a square mile in area and over two miles in length, many cases arose where slower methods of transportation would have proven costly and delayed the completion of the work on time.

The Exposition required for the use of its construction departments 20 Ford automobiles and 14 trucks, of which two were 5-ton, three 2-ton, two 1½-ton, four 1500-lb. and three 800-lb. Just prior to and some time following the opening day this equipment was operated 24 hr. per day, and additional equipment was rented to meet the unusual situation at that time. While the construction program had been practically completed prior to opening day, there was an enormous amount of work incident to getting exhibits installed and cleaning up the grounds. It is estimated that within the last twenty-six hours something like 10,000 tons of debris of various kinds was hauled to the dump and burned.

The transportation of visitors within the grounds was solved to the apparent satisfaction of the public by the use of the auto train consisting of a small tractor and several trailers. The cars of the auto train are low enough to permit passengers to step directly on to the platform and the routes are such that the trains pass within 100 ft. of all buildings. The seats run the whole length of the cars, which have an aisle in the center for the conductor. Each car accommodates 20 passengers, and the gasoline tractor, which is equipped with a Ford engine, is capable of hauling three cars.

FIRE PROTECTION

Certainly no exposition had a fire protection system comparable with the one installed at this one, and it may safely be said that few communities enjoy an equal security against fire. Located as it is within the city proper and close to the residential district, the Exposition represents a tremendous fire hazard to the city, and the problem of fire protection was carefully studied by the engineers of the Exposition in consultation with the Board of Fire Underwriters. In compliance with the general plan adopted, a high pressure water system was installed throughout the main portion of the grounds and as far west as the Live Stock section.

The system was designed to operate as a part of the city's auxiliary water supply system and to be capable of delivering 15,000 gal. per min. at any hydrant, at a pressure of 200 lb. per sq. in. The distribution system includes 52,000 lin. ft. of pipe in sizes from 6-in. to 16-in. lap welded pipe and Dresser all-steel couplings are used throughout, with extra heavy flanged cast-iron fittings and valves. All hydrants are of the flush type, set in circular concrete manholes with wooden covers. The hydrants have two 3-in. outlets and are spaced approximately 300 ft. apart. With the exception of the Fine Arts and Horticulture buildings, the high pressure system is brought into all exhibit buildings. Four 8-in. pipes are run into each building, one from each side, and serve the inside and roof hydrants, the automatic sprinkler system, the cornice sprinklers and the roof monitors.

The 8-in. valves controlling the supply to the buildings are kept closed, but the 4-in. by-pass valves are left open. This practice was adopted to limit the damage in case of a break inside the building. These 8-in. control valves are located outside the buildings, and in the same manholes are installed 6-in. cross connections to the low pressure supply, with check and gate valves, so that in the event of a failure in the high pressure supply the sprinklers will be fed from the low pressure system. The roof and inside hydrants have 3-in. outlets, and are so located that any portion of the roof or floor can be reached with 150 ft. of hose. The monitors have a capacity of 1500 gal. per min., and are set so as to play on the buildings opposite them as well as on the roofs on which they are located. The cornice sprinklers are arranged to produce a water curtain on the sides of the buildings which face one another and are less than 150 ft. apart.

Automatic sprinklers are installed in all exhibit buildings, with the exception of the Palaces of Machinery, Horticulture, Fine Arts, the Festival Hall and the administration portion of the California building. The domes in the eight buildings of the main group and the ceiling of the Palace of Machinery are not equipped with sprinklers, as the height is so great that the effectiveness of sprinklers is questionable.

In the design and construction of the buildings fire protection was borne in mind. Concealed spaces where a fire might flourish unobserved were carefully avoided, and heat curtains were used extensively to prevent circulation of air and insure the confinement of heat and operation of the automatic sprinkler and fire alarm systems. Reinforced concrete firewalls were built where the architectural requirements resulted in buildings being connected by colonnades or other decorative features. The exterior building walls were carried down to the ground surface and sheathed on the inside to a height of 12 ft. above the floor. The roofing used had a top sheet of either crushed brick or asbestos, and wire glass was used in all skylights, preventing fire being caused by anything falling on roofs.

Additional protection was afforded by hydrants connected to the domestic water supply system by the installation of 3-gal. chemical fire extinguishers and by suction pipes at the various parts to be used in connection with fire engines.

The fire department is operated as a part of the city's department, which answers all alarm calls on the E position grounds. Three fire houses, with equipment, are located on the grounds. A complete fire alarm system was installed

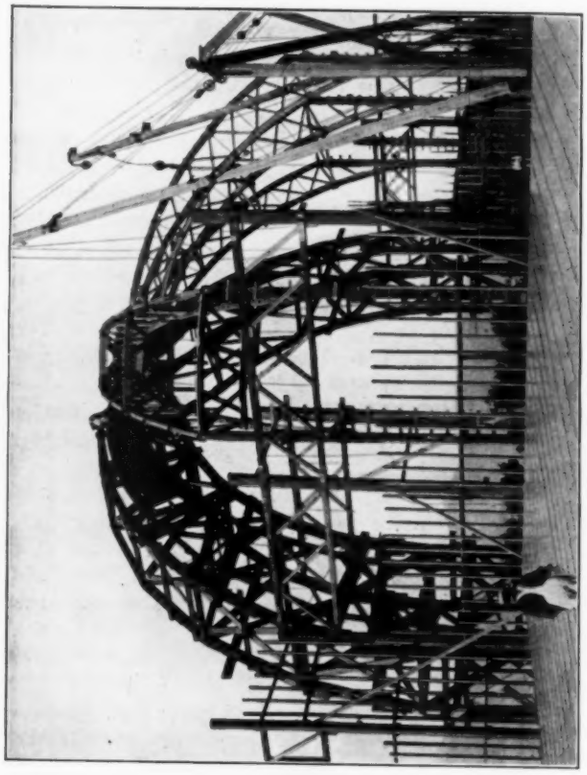


FIG. 13 FRAMING OF HALF DOME, FOOD PRODUCTS BUILDING

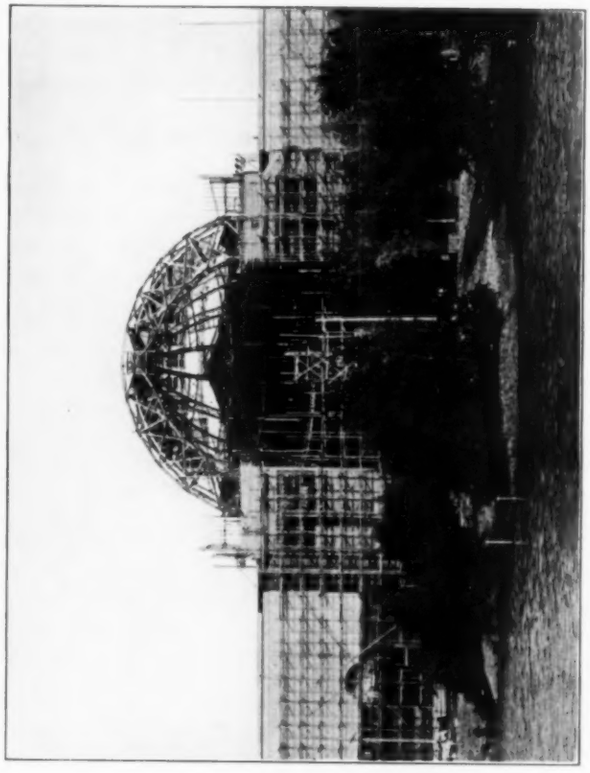


FIG. 15 FRAMING OF HALF DOME, PALACE OF EDUCATION

FIG. 12 TYPICAL TIMBER DOME CONSTRUCTION

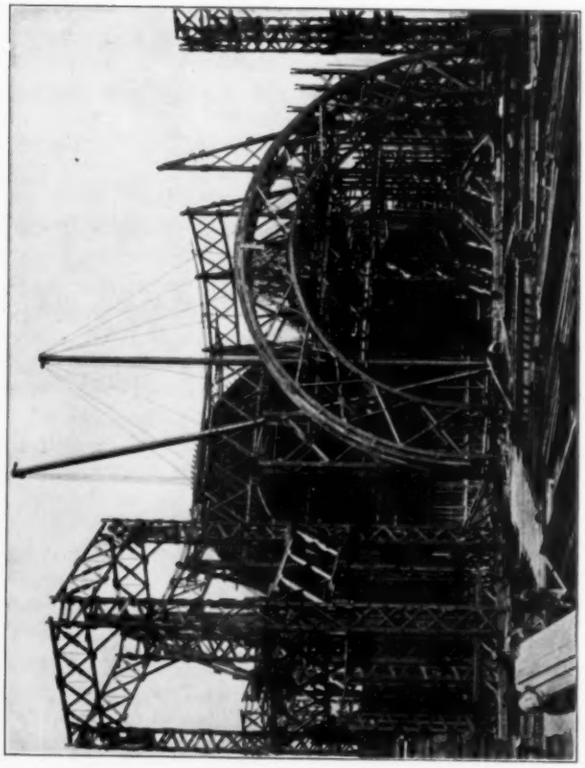


FIG. 14 FRAMEWORK OF FESTIVAL HALL

and a complete central office located in the Liberal Arts building is operated as an exhibit.

All exhibit buildings and many of the detached buildings, especially those having moving picture apparatus, are equipped with an automatic fire alarm system of the pneumatic tube type. Copper tubing not exceeding 1000 ft. in length is run around the ceilings or parts of buildings where heat from a fire would quickly affect the tubing. The tubing is 0.09-in. outside diameter with a hole approximately 0.045 in. in diameter. One end of each tube is connected to a detector, consisting of a sensitive metallic bellows such as is used in aneroids. In the event of a fire the pressure of the air in the tubing is increased, due to the expansion of the contained air and the bellows expands and closes an electric circuit, which in turn sends a signal to the central fire alarm station and to the annunciators placed at the building entrances to inform the fire department of the location of the fire. The bellows mechanism or detector is located in a steel cabinet which contains five detectors, each connected to about 1000 ft. of tubing. The buildings of the main group have at least five of these cabinets in each building, and some as many as eight, while the buildings of minor importance have a lesser number.

The fire protection measures adopted by the Exposition cost in the neighborhood of $900,000, but the fire losses up to August 1 have been insignificant and the security obtained has warranted the Exposition carrying only a nominal insurance on completed buildings.

MECHANICAL FEATURES

Power Plant. With three large electric companies in the field, each capable of supplying needs of the Exposition, the necessity for building a power plant was not considered. The Pacific Gas and Electric Company, which furnishes electric energy to the Exposition, has a substation on the grounds, and the interesting feature of a power plant in operation is supplied by the Sierra and San Francisco Power Company, whose 18,000-kw. plant is located within the grounds, about 500 ft. east of the Palace of Machinery. This plant is operated in conjunction with a hydroelectric system for supplying energy to the United Railroads, and is an excellent example of a standby station with steam turbines and oil-fired boilers. Under an arrangement with the Pacific Gas and Electric Company, this steam plant is kept in operation continuously, so that in the event of an interruption in the regular source of supply it will carry the load of the Exposition.

Heating and Ventilating Equipment. With the exception of the spaces occupied as offices, no heating was provided for the main exhibit buildings other than the Service building, Administration building, Press building, Festival Hall, Palace of Horticulture and the Auditorium at the Civic Center.

The heating of Festival Hall is a departure from standard practice in that a system was installed using gas-fired hot-air heaters with forced circulation. While gas at 75 cents per 1000 cu. ft. is an expensive fuel, its use for the short period of the Exposition was justified by the saving in the initial cost of the plant as compared with a steam plant. The heaters and supply fans are located in two rooms, one on each side of the main auditorium. Each fan room contains two steel plate fans, each having a capacity of 1500 cu. ft. per min., and four hot-air furnaces, each capable of burning 440 cu. ft. of gas per hour. The arrangement is such that one fan serves two heaters and delivers air through registers located in the columns around the main entrance, while the other fan discharges into a plenum chamber beneath the raised side seats, openings being provided in the risers for the discharge of air into the auditorium. Air is removed from the auditorium by two multi-blade exhaust fans installed beneath and on each side of the stage, and having a combined capacity of 5200 cu. ft. per min. All fans are belt-driven by direct current motors equipped with armature control.

In the California building, the administration quarters are heated by 8700 sq. ft. of direct radiation with vacuum returns. Steam for the heating system and for the hot-water supply and kitchen equipment is supplied by two oil-fired, cast-iron boilers operated at a pressure of 5 lb. Ventilation for the ball room is secured by two 60-in. disc fans located in the attic space.

To provide the necessary heat in the dome portion of the Palace of Horticulture, which is essentially a large conservatory, a hot-water system with forced circulation was adopted. The hot water is supplied from a model boiler plant located about 90 ft. south of the main building, in which are installed two oil-fired cast-iron boilers equipped with vertical, rotary burners. Owing to the architectural requirements of the neighborhood, it was undesirable to use a tall stack, and smokeless combustion has been secured with a stack which is only 30 ft. high from the burners and terminates in the staff basket. Forced hot-water circulation is produced by two 4-centrifugal pumps designed to operate against a head of 40 ft., each direct-connected to a 7½-h.p. induction motor. Recording thermometers and a flow meter enable accurate records to be kept of the amount of heat delivered by the plant.

The heating required for the section beneath the dome was calculated on the basis of 3,725,000 cu. ft. of space, 54,650 sq. ft. of glass surface, and 15,470 sq. ft. of wall surface. It was assumed that there would be one complete change of air every three hours and a loss of six B.t.u. per hr. per sq. ft. of wall surface and 17 B.t.u. per hr. per sq. ft. of glass surface, making a total of 1,376,800 B.t.u. required per hour to maintain a temperature of 50 deg., with an outside temperature of 35 deg. The four rooms adjoining the dome section were figured for temperatures from 60 to 80 deg. fahr., which brought the total requirements of the building to 3,582,000 B.t.u. per hr., requiring the circulation of 190,000 lb. of water per hour, with an initial temperature of 250 deg. and a loss of 20 deg. Radiators of the cast-iron type were used instead of the customary pipe coils, with satisfactory results. Thermostatic control was installed in several of the rooms for regulating the temperature of ponds. The plan of using forced circulation and high temperatures made possible a material reduction in the size of the mains and the quantity of radiation required.

Minor heating installations were provided in various buildings, such as the Service building, which is heated by direct steam radiation of the single-pipe system, while the Press building is heated by the Rector system, which burns gas in connection with cast-iron radiator elements, the products of combustion being removed by means of a fan located in the basement. The offices in the Exposition palaces and most of the buildings erected by participants are heated by gas radiators or gas stoves of the radiant type, flues being provided to carry away the products of combustion.

Owing to the fact that the Auditorium in the Civic Center is a permanent, four-story, fireproof building, a modern heating and ventilating system was installed. In order that the main hall might be used for dances and other functions, a system of heating and ventilating was adopted which left the floor free of obstructions. Fresh air is forced through the openings in the balcony risers and grilles along the face of the balcony. The grilles are supplied from separate ducts, whereas the openings in the risers receive their supply from a plenum space beneath the balcony seats. Exhaust fans are provided to remove the air through large grille plates beneath the balcony, along the side walls and through smaller grille plates above the balcony, and just below the base of the auditorium dome.

For supplying fresh air, two fans are installed in the

FIG. 16 INTERIOR OF DOME, MINES BUILDING

basement, each having a capacity of 145,000 cu. ft. per min. Two main exhaust fans, each capable of handling 70,000 cu. ft. per min., are installed in the attic, and two exhaust fans of 75,000 cu. ft. per min. capacity in the basement. Additional supply and exhaust fans are provided for the banquet rooms, toilets and kitchens, these fans having a total rating of 39,000 cu. ft. per min. The fans, of which there are 18, and the vacuum pumps, are belt-driven by motors aggregating some 250 h.p. Heating coils are used in connection with the various fresh air supply fans, and provision has been left for air washers should they ever be found necessary. Direct radiation is used for the upper corridors, convention halls and offices.

Pumping Plants. In addition to the pumping plant described under the heading of Water Supply, numerous pumping equipments were installed throughout the grounds in connection with the fountains, the pools, the drainage beneath the buildings, the handling of sewage and the supply of salt water. Belt-driven centrifugal pumps were adopted as a standard, as they permitted the use of rented motors, were lower in first cost, and carry a higher salvage than direct-connected pumps. Another reason for the adoption of the belt drive was the ease with which the pump speeds could be changed to meet conditions of operation different from those planned.

The pumping equipment of a fountain is a simple problem compared with that of laying out the distribution piping and deciding on the form, size and adjustment of the nozzles. It was found that the use of lead pipe for connection to nozzles expedited the work of adjustment, and in many cases the nozzles themselves were formed from lead pipe. Experience indicates that valves or cocks should not be placed close to nozzles as they disturb the flow of water and prevent the realization of a smooth and solid stream. Where groups or decorations are liable to be constantly wet, they should be made of cement, as staff will fail, even though the water may not play directly on it. If canvas is used for lining basins or pools it should be painted on both sides and thoroughly protected against damage from workmen's shoes. Sixteen motors, aggregating 755 h.p., are used for driving pumps to produce water effects.

Transfer Table. The arrangement of the Palace of Transportation necessitated bringing all rolling stock into the building on one track and distributing this equipment to 14 exhibit tracks by means of a transfer table. This transfer table had to be designed to carry the largest locomotives and cars of which, up to that time, there was any record. A standard steel transfer table would have cost from fifteen to twenty thousand dollars, and its salvage value would have been problematical. The transfer table as built cost $7000, exclusive of foundation. Its deck is 76 ft. long, and it is made up of timber stringers on which are laid the ties and track. This deck is supported on 14 trucks, two trucks to a track. Each pair of trucks is tied together with stringers which carry the deck and transmit the load to the trucks through special steel bolsters. No springs are used and, barring the flexibility due to the timber work, the table is a rigid structure.

The transfer table has a 300 ft. length of run and is moved back and forth by two hauling lines and two tail lines. One hauling line and one tail line are attached to the deck near each end, and this arrangement keeps the table in alignment at all times. Each hauling line, with its companion tail line, is rove on one drum in such a manner that as one line runs off the drum the other fills the space vacated. This method successfully prevents the cables from overriding and admits the use of a smooth face drum. The two drums are geared to a countershaft which is belt-driven by a 35-h.p. variable-speed induction motor.

Traveling Cranes. To facilitate the installation of heavy exhibits three bays in the Palace of Machinery were equipped with traveling cranes. The center bay has two 30-ton cranes with 5-ton auxiliary hoists, and each adjacent bay has a crane of 20 tons capacity. These cranes have a span of 67 ft. 8 in. and are of standard steel construction, with 3-phase, variable-speed motors. These cranes were all obtained on a rental basis, the sum of $13,600 being paid for their use,

which amount also includes the erection and dismantling of the cranes.

Refrigeration Plants. Refrigeration service was considered desirable in the Palaces of Horticulture and Food Products, and refrigeration plants were accordingly installed in these two buildings. The apparatus was installed by exhibitors, but was operated at the expense of the Exposition, which in turn sold refrigeration service to various exhibitors and participants. Subsequent events, however, proved that the use of small individual plants, or ice, would have been more satisfactory than a central plant and distribution system, because the needs of the consumers were nominal.

In the Palace of Horticulture the central plant is an exhibit of the Automatic Refrigerating Company. The principal feature of this installation is its automatic control, a thermostatic switch starting and stopping the motor according to the changes in temperature of the refrigerated space. The water for the condenser is automatically regulated to meet load requirements and is shut off entirely when the motor stops. Should the water supply fail the motor will stop automatically and will start again when the water supply is resumed. The plant has a rated capacity of $3\frac{1}{2}$ tons of refrigeration per day. The piping is 1000 ft. long, $1\frac{1}{4}$-in. diameter, and is covered with cork insulation. Although this plant receives but little attention, the results are most satisfactory.

The central plant in the Palace of Food Products was installed as a working exhibit by the York-California Construction Company and consists of two double-cylinder, double-acting, vertical compressors—one of 20 tons and the other of 4 tons refrigerating capacity, both belt driven by motors. Brine is chilled and circulated through the distribution piping to the various exhibits. This piping is not covered, as it is cheaper to waste power during the short period of the Exposition than to provide insulation. To prevent waste of water an inexpensive cooling tower was built 4 ft. by 8 ft. in section and 25 ft. high. Spray heads were installed half way from the top of the tower and the air for cooling purposes taken from beneath the building floor and blown through the tower by a 30-in. disc fan. The discharge of air from the tower directly into the building has not proven objectionable.

Repair Shops. Early in the progress of construction work machine and blacksmith shops were fitted up to care for general repair work and later for the manufacture of electric standards and fixtures. All of the iron work used in the construction of the gas and electric standards was fabricated in the Exposition's shops.

ELECTRICAL FEATURES

One of the earliest problems for settlement was that of securing a supply of electrical energy for the construction and operation of the Exposition. Owing to the fact that there were three electrical companies, with steam stations within the city and connections to extensive hydroelectric systems, the Exposition was in a favorable position to negotiate for the purchase of electric energy.

In order to arrive at a figure sufficiently close for the purpose of making a contract for electric service, the areas of the buildings, courts, gardens and avenues were computed and various light intensities assumed for each. Tungsten units were figured for use in the buildings and courts, and magnetite arc lamps for the gardens and avenues. The load in the concessions area was assumed as being 80 per cent of the connected load in the concessions area of the St. Louis Exposition. The amount of load for exhibitors was guessed at, as there was no information available on this point. These rough calculations indicated that the average peak would be 8500 kw., with a maximum of 11,500 kw. during the winter season when the day load would overlap the evening load. It was decided to compare proposals on the basis of a 12,000-kw. maximum load and a load factor of 30 per cent.

On Feb. 28, 1913, a contract for supplying electric service was entered into with the Pacific Gas and Electric Company, under the terms of which the Exposition was to pay 2 cents per kw-hr. during the pre- and post-exposition periods, and during the actual period of the Exposition a fixed charge of $18,000 per month, plus an energy charge of 0.6 cents per kw-hr. For the fixed charge named the Exposition was entitled to take loads up to 15,000 kw., but was

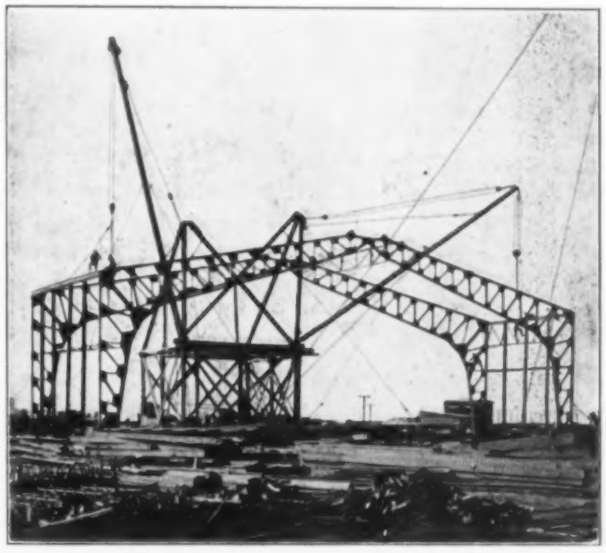


FIG. 17 THREE-HINGED ARCH CONSTRUCTION, PALACE OF FINE ARTS

to pay $2.00 per month per kw. for the excess demand over and above this amount. At the time this agreement was signed, there was every reason for assuming that the maximum load would be 12,000 kw. or more, but owing to the period of financial depression which followed, and the European war as a climax, a large number of prospective foreign and domestic exhibits were withdrawn, and the maximum load realized has not exceeded 8100 kw., with an average maximum of 7880 kw. On the basis of this average maximum and the charge for energy, the cost per kw-hr. has averaged 1.7 cents.

An agreement was entered into with the Pacific Gas and Electric Company, whereby it was to furnish the Exposition, for use during the Exposition and during the construction and dismantling periods, all of the electrical apparatus, instruments, materials and appliances which might be required, except building wiring, searchlight projectors and other special apparatus not in general use by power companies. For the use of this apparatus the Exposition agreed to pay 5 per cent of the cost of the apparatus to the Pacific

Gas and Electric Company as a rental, independent of the length of time the apparatus had been in use, and to pay outright for all apparatus not returnable.

Included in the contract for electric service was the requirement that the power company should install a sub-station on the grounds and a 5000-kw. steam standby plant. This requirement was later modified by an agreement between the Pacific Gas and Electric Company and the Sierra and San Francisco Power Company under the terms of which the Pacific Gas and Electric Company installed its sub-station in the west end of the Sierra and San Francisco Power Company's power house, and received standby service from its 18,000-kw. turbine plant. As the power house mentioned is within the grounds and the plant was to be kept running during the period of the Exposition, it was felt that the protection of service thus secured was even greater than under the terms of the original contract.

In fulfilment of the terms of the contract, the 60-cycle, 3-phase energy used by the Exposition is generated at Station A, which is in the southern part of the city. This station has a capacity of 52,000 kw. in steam prime movers and, in case of breakdown or overload, takes electric energy from the power company's 60,000-volt transmission lines which terminate at Martin Station, at the southern boundary of the city, where the voltage is reduced to 11,000 volts. To transmit this energy three 4/0, 3-conductor, 11,000-volt cables run underground from Station A direct to the sub-station on the grounds, known as Station F.

Primary Distribution System. Power from Station F is distributed throughout the grounds by means of fifteen 3-conductor, 3-phase, 4100-volt feeders and two 11,000-volt, 3-conductor, 3-phase feeders. With the exception of the overhead lines in the concessions district, and the extreme westerly end of the grounds, the distribution is from an underground system.

Secondary Distribution. With the exception of the areas mentioned, where overhead lines are installed, alternating current at secondary voltages for light and power purposes is taken from transformer vaults which are in reality minor sub-stations in which the primary cables terminate and the high-tension switch gear and transformers are installed. All buildings are furnished with energy for light from 3-phase, 4-wire mains connected to the distribution boards on the transformer vaults. This arrangement provides 115 volts from any conductor to neutral, and consumers are served from one, two or three of the phases, depending upon the size of their load. Power is supplied from separate transformers and the distribution is at 230 volts from 3-phase, 3-wire mains.

FIG. 18 FRAMING OF PALACE OF MACHINERY, SHOWING CONNECTIONS AT INTERSECTIONS OF BAYS, ALSO FRAMING FOR CRANE

Electric Rates. Electric service is furnished at flat, meter and special rates, as follows:

Flat rate: Electric installations having a connected load to any given service of less than 2 kw. are charged at the rate of $15 per month per kw. of connected load, with a minimum of $2.50 per month where the load is 166 watts or less. This rate is based on the understanding that the entire connected load will not be used more than 240 hours per month.

Meter rate: Consumers having connected loads in excess of 2 kw. are provided with meters, and electric service is charged for on the basis of $2.50 per month per kw. of connected load, and an energy charge of 5 cents per kw-hr., with

a reduction of 0.1 cent for each 1000 kw-hr. used per month up to 20,000 kw-hr. and 3 cents per kw-hr. for the balance.

Special rate: All exhibitors in the main palaces were given lighting service at rates 25 per cent less than the foregoing, and power service at a rate of 3 cents per kw-hr. The connected load was estimated from the manufacturer's rating of the apparatus and in most instances was the maximum demand.

An exception to these rates was made in order to encourage participants in the States and Foreign sites to illuminate their buildings, and no fixed charge was made on lights installed for exterior decorative purposes.

Direct Current System. Direct current for the operation of searchlights and projectors is generated by two 1000-kw., 250-volt generator sets and two 250-kw., 125-250-volt balancer sets. These units are installed at the various load centers in order to reduce to a minimum the distribution copper required, but are all operated in parallel.

Underground Conduit System. The underground conduit system is approximately 30,000 ft. in length, and comprises 300,000 ft. of duct. The short life of the Exposition necessitated an economical design, and a type of conduit construction was adopted based on the use of fibre duct with ⅛-in. walls (Linaduct), and wooden manholes. The ducts were laid on a box or trough extending between manholes which varied in size to suit the number of ducts. The space between the ducts and the box was filled with sand sluiced into position with water, except at the entrance to the manholes, where concrete was used for a distance of 4 ft. to prevent the ducts being displaced by cable pulling operations.

The boxes were made up in the mill and delivered in 14-ft. and 20-ft. lengths, which were made continuous by splice pieces nailed to the sides and bottoms. The load on the bottom boards was transferred to the sides by means of 1-in. by 4-in. strips fastened to the bottom and sides and spaced 4 ft. apart, the corners held by iron straps. After the boxes were filled flush with sand, pieces were nailed across the top. This form of construction proved to have great mechanical strength, and there were many instances where building materials were piled upon exposed lines, and spans of 10 ft. or more were left unsupported as a result of undermining for other utility mains, without damage to the conduit. The conduit system was laid before the streets were paved, but was not damaged by the teaming or road rolling. In fact, a damaged duct or a misplaced one has never been discovered.

FIG. 19 FRAMING OF PALACE OF MACHINERY

Lighting Standards. The design of the foundations for arc standards was given careful study, as most of the standards were to be set in a soft dredger fill. The standards fitted with banners, in particular, were liable to blow over in high winds, as the exposed area was large and the arrangement ideal for catching the wind. These poles are 40 ft. high, 13½ in. in diameter at the ground line, 4 in. in diameter at the top, and carry from 5 to 7 arc lamps which weigh 100 lb. each. The banners have an area of 50 sq. ft. with the center of pressure from 25 ft. to 35 ft. above the ground line. The other design of arc standard has a staff decoration on the top which, owing to its size, shape and weight, presented almost as severe a problem as the banner type.

Considering that there are 200 of these standards, the foundations for which involved considerable expenditure, experiments were carried out with various forms of foundations to determine the least expensive type of construction which would meet the rather unusual conditions. The result of these experiments was the adoption of a reinforced concrete slab placed 6 in. below the ground surface and supported by piling. The piling consisted of 2-in. by 6-in. pieces which were jetted into place in advance of the concrete work. Spikes were driven near the tops of the piling, which were embedded into the concrete, and served to transmit to the piling any uplifting forces due to the turning moment developed by the wind. The concrete slab was made in the form of a cross to insure a sufficient spread with the minimum of material, and a hole was left in the center to receive the pole, which was grouted in after setting. These foundations cost $35 each, and although storms have been experienced which tore away the banners in some instances, none of the foundations has failed.

Illumination. With the realization that illumination had become a branch of engineering, a specialist in that field was employed to design the general scheme for lighting the Exposition, which was later adopted and made the basis for detailed plans and estimates. Slight changes were later made to obtain the desired effect.

The perfection of the illumination produced is largely the result of an appreciation by the engineers of the aesthetic qualities of the work of the architects and artists, and it was therefore possible to secure their coöperation, which was of the greatest value, particularly in the settlement of prob-

lems relating to color, and the location, scale, mass and decoration of the lighting standards.

The general scheme of illumination adopted was to use flood lighting from hidden projectors and massed lighting from arc standards, exposed sources being used in gardens and along roadways where the treatment admitted of incandescent standards. The illumination was described in detail by the writer in the Feb. 13, 1915, issue of the *Electrical World*.

The flood of light on the various towers is produced by searchlight projectors hidden on the roofs of buildings and outlying structures. For the flood lighting of the 6 towers, the Palace of Fine Arts and the large groups of statuary, thirteen 30-in. and two hundred 18-in. searchlight projectors

FIG. 20 BATTERY TRUCK CRANE WITH EXTENSION TO BOOM FOR HANDLING STANDARDS

are used. Most of these are fitted with dispersion doors which spread the beams anywhere from 10 to 40 deg., depending upon the design of the strip lenses in the door. In some instances double doors are used, one of which spreads the beam horizontally and the other vertically.

The searchlight projectors are of the manual control type and most of them are equipped with parabolic mirrors, while the balance have Mangin mirrors. The latter type of mirror is not suitable for lighting building surfaces, as it produces a spectrum at the circumference of the field illuminated, but for lighting groups which occupy only a portion of the field this type of mirror is satisfactory. Gelatine color screens are employed in connection with the searchlight projectors and by their use the color tone of the Exposition can be readily changed.

The strong light from the projectors would cause deep and sharp shadows, and to neutralize this effect the shadows are illuminated by concealed incandescent lamps which are dipped an orange color. On the towers these lamps are located behind the columns, at the floor levels. To have wiped out the shadows entirely would have resulted in a flat effect, and no feature has contributed more to the charm of the lighting than the treatment of the shadows with color.

A decorative feature is the use of imitation jewels in connection with the illumination of the upper portion of the main tower, where over 100,000 are used, while 25,000 are used elsewhere. The jewels are made of glass and vary in size from 21 mm. to 47 mm. They are cut with facets similar to those of a diamond, and a small mirror is mounted behind each to increase the number of flashes obtainable. These jewels were made in Austria and their cost ranged from 33 cents for the 47-mm. size to 6 cents for the 21-mm. size. Although the jewels are of various colors, most of them are amber. They are mounted in holders which are attached to supporting hooks, allowing them freedom to swing in the air currents. Under the powerful rays of the searchlights the jewels sparkle and glitter and contribute an element of action and color which is most striking. The jewels have never been cleaned and the difference in appearance after 5 months' use is not noticeable.

The flood lighting feature for the building wall surfaces is provided by magnetite arc lamps set on ornamental standard 30 ft. high and spaced from 60 ft. to 75 ft. apart. Two types of standards are used, one having a large curved shield of staff with three openings fitted with orange colored translucent fabric; the other has a combination of three canvas banners painted with heraldic emblems. The design of both types is such that the lamps are not in the line of sight, but allow a small amount of colored light to pass. Lamps were used on these standards in combinations of 2, 3, 5 and 7, depending upon the distance of the standards from the building walls. Some light was reflected back from the building walls, but not enough to illuminate the adjacent avenues, and additional lighting was provided by means of single-light electroliers made of staff and equipped with 250-watt Mazda lamps and 18-in. glass globes.

Similar electroliers, carrying from 1 to 21 globes, lighted the South Gardens, Court of Palms and the entrances to some of the other courts. Special globes were used which, while they contributed a mellow diffused light at night, produced a discordant effect during the day, owing to their whiteness as compared with the color tone of the travertine finish of the buildings. A lacquer, into which color was mixed, was used to overcome the objectionable appearance of the globes.

The globes were all in position at the time it was decided to spray them, and for this purpose a portable rig was made consisting of an air compressor and four potter's wheels, which was moved around from standard to standard, the globes placed on the wheels and sprayed with the lacquer by means of an air brush. The lacquer coating caused some loss of light, but not enough to make a noticeable difference in the illumination.

An element of life is given to the night picture of the Exposition by the buildings appearing to be lighted up inside, which effect is produced by Mazda lamps fitted with tin reflectors and suspended back of the various building openings. The color effects in some locations are obtained by using dipped lamps and in others by painting the glazing.

The kaleidoscopic colors and shapes which appear in motion on the glass dome of the Horticulture building are

produced by twelve 30-in. searchlight projectors placed beneath the center of the dome and arranged to project their beams through revolving lenses and color screens. Eight color screens and twenty lenses are used in connection with an opaque sector disc. These three elements are mounted on a vertical shaft and slowly revolved at slightly different speeds. Various combinations of shapes and colors are thus projected upon the dome, but the effects are rather thin, owing to the fact that the quality of glass used does not intercept a sufficient amount of light.

Without doubt the most spectacular feature of the illumination of the Exposition is the so-called scintillator, located on the Yacht Harbor. The equipment consists of forty-eight 36-in. searchlight projectors of the manual control type and is used in connection with pyrotechnic displays and steam effects, in addition to being used nightly in the form of a great fan as a background to the illumination. The color screens used in connection with these lights are wooden frames with gelatine sheets held between chicken netting. The gelatine sheets are waterproofed with spar varnish for protection against moisture. The searchlights are operated by 52 U. S. marines under a commissioned officer.

The illumination of the Exposition buildings and grounds, not including the States and Foreign section, produces a load of 5216 kw., of which 1700 kw. are used for the searchlights, 450 kw. for the arc lights and 3066 kw. for the incandescent lighting. The cost for electric service chargeable to illumination is $630 per night, and for labor, repairs and maintenance $125 per night. The lighting of the emergency gas lights costs about $35 per night, and the gas lighting in the States and Foreign sites about $40 per night. In round numbers the cost to the Exposition for lighting is $830 per night, which sum includes all operating costs, but no capital charges.

GAS DISTRIBUTION

Gas for the use of the Exposition and its participants is purchased wholesale from the Pacific Gas and Electric Company and is retailed by the Exposition through a system of high-pressure distribution mains which were installed by the company for this purpose. The gas used is manufactured from oil at the company's Potrero plant and is transmitted across the city at a pressure of 80 lb. Two Thomas electric gas meters measure the high pressure gas supplied to the Exposition. The distribution mains extend throughout the grounds, an 8-in. ring surrounding the main group, with an 8-in. loop into the States and Foreign sites, and a 4-in. loop into the Zone. Other areas are supplied from 4-in., 3-in. and 2-in. mains laid to form loops or rings. Lap welded pipe was used for the 8-in. and 4-in. mains and standard pipe for the smaller sizes. In all there were 100,000 ft. of pipe laid. All joints and connections to the mains were welded by the oxy-acetylene process and the connections were tested with high pressure gas before backfilling.

The various palaces were equipped with low-pressure 4-in. and 6-in. ring mains which were fed at one or more points by 3-in. service connections from the high-pressure mains. Pressure governors within the buildings reduced the gas pressure to 6-in. water gauge, and oil seals were installed close to the governors for protection against an increase in pressure in the domestic distribution system due to a failure of the governor. Consumers located within the Exposition buildings are supplied from the ring mains, while those in the States and Foreign sites are connected to the high-pressure mains, with a regulator set on their premises to reduce the pressure. In the States and Foreign sites, and on top of all kiosks, high-pressure gas lamps are installed. Each lamp has a small regulator which reduces the pressure to 3 lb., but oil seals are not used in connection with these installations. Some 257 of these lamps are in use, with excellent results. Low-pressure gas arcs are installed on poles along the Zone for emergency lighting. The distribution of gas lamps throughout the grounds is such that in the event of a failure of the electric service, people could get about without inconvenience.

With a view to public safety gas lamps were installed for

FIG. 21 LOCO CRANE WITH EXTENSION BOOM RAISING STATUARY

all emergency and exit lighting. Gas is sold to consumers at the rate of $1 per 1000 cu. ft. for the first 50,000 cu. ft. used in any one month, and 80 cents per 1000 for a consumption in excess of this amount up to 300,000 cu. ft., at which point a sliding scale is applied which reduces the price to about 70 cents per 1000 cu. ft. for some of the large consumers.

Gas is the only fuel allowed on the grounds, with the exception of plants which are sufficiently large to warrant the employment of an engineer. In such installations the use of oil-fuel is permitted.

The average quantity of gas used on the grounds is from 12,000,000 to 15,000,000 cu. ft. per month.

WATER SUPPLY

Preliminary estimates indicated that the average consumption of water would be about 1,258,000 gal. per day with a

possible maximum of 2,525,000 gal. per day. In the absence of any exact data for guidance, and in order to be on the safe side, the pipe sizes of the distribution system were figured on the assumption that the average consumption would be 2,000,000 gal. per day and the maximum 3,500,000 gal. per day. The maximum rate of flow was assumed to be 1½ times the maximum daily consumption.

Sources of Supply. In view of the fact that there was the possibility of San Francisco acquiring the plant of the local water company by condemnation proceedings, the Exposition found it impossible to arrange for a water supply from this source. A survey of the situation indicated the possibility of securing about 800,000 gal. per day from the water supply system of the Presidio and the balance by developing the underground storage waters in and near Golden Gate Park, with a small additional amount of water from wells on the grounds.

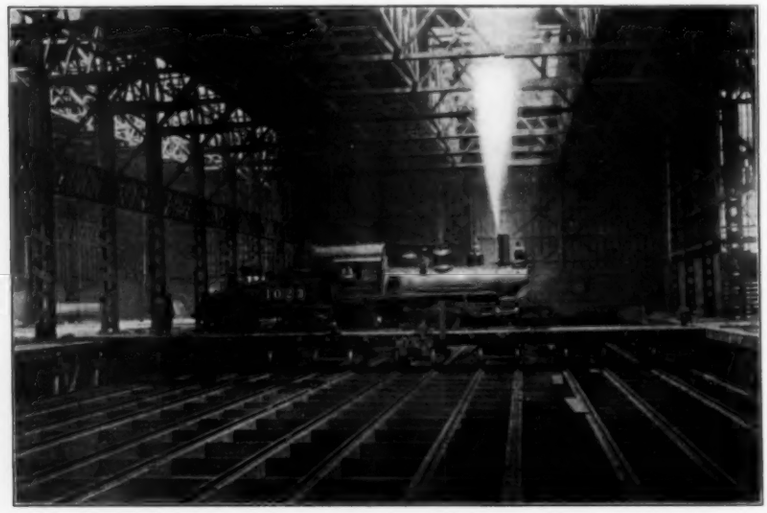


FIG. 22 TRANSFER TABLE, PALACE OF MACHINERY

The Presidio allowed the Exposition the use of one of the compartments of its storage reservoir and the arrangement was such that when the Presidio's compartment was full the excess would spill into the compartment allotted to the Exposition. This reservoir is at an elevation of 384 ft. and the capacity of one compartment is 3,000,000 gal. As soon as this contract was closed, the U. S. Government allowed the Exposition to tap its 8-in. line to Fort Mason, which passed through the grounds, thus giving the Exposition immediate relief from a threatened shortage of water during the construction period.

Golden Gate Park Supply. No time was lost in making tests for water in the vicinity of Golden Gate Park, for it was generally known that a considerable quantity of water was to be found in that district due to the absorption of the rainfall by the sandy soil. Seepage downward is prevented by a stratum of clay at a depth of from 60 to 90 ft. from the ground surface, but there is a flow toward the ocean at a rate of from 10 to 30 ft. per day.

From a careful study of the situation, it was estimated that a supply of 1,000,000 gal. per day could be relied upon during the period of the Exposition, which estimate was to a degree verified during the investigations by the work of a sewer contractor in the vicinity of the proposed plant, who found it necessary to pump 1,000,000 gal. per day to unwater his trench. The first step taken was to construct in the westerly end of Golden Gate Park an infiltration sump similar to that used by the Park Commission for their supply of irrigation water. This sump was made 200 ft. long, 14 ft. wide and 30 ft. deep. Tongue and groove sheet piling was used to keep out the surface water, while removable screens placed near the bottom collected the water of desired quality. This sump developed a yield which indicated it could be depended upon for 350,000 gal. per day, but owing to the high cost of construction for the output secured, it was decided to try sinking wells, although it was brought to the notice of the engineers that wells had been tried before in that territory and abandoned on account of inability to keep out the sand.

The desperate situation justified taking a chance and a test-well was bored just outside the park, which was brought up to a capacity of 368,000 gal. per day without encountering any difficulty with sand. This well was 80 ft. deep, with an outside casing 20 in. in diameter and an inside casing 16 in. in diameter.

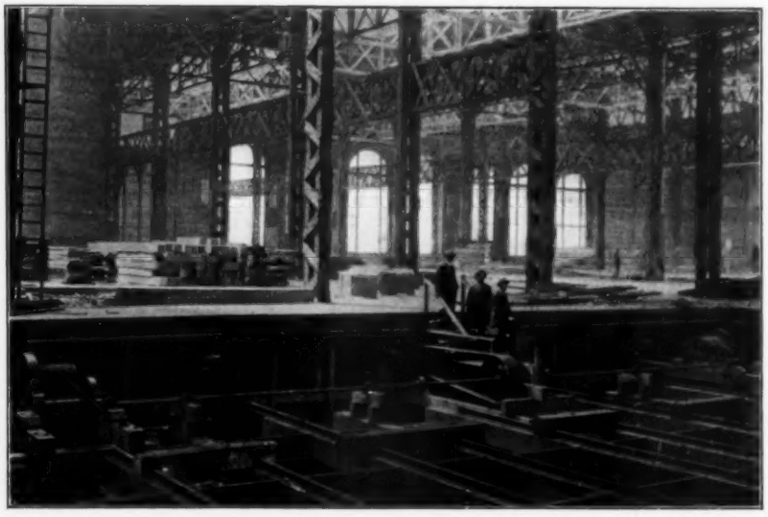


FIG. 23 HAULING GEAR FOR TRANSFER TABLE

Both casings were perforated with slots having $^{1}/_{16}$-in. openings, and the annular space between casings filled with gravel ranging from rice to pea in size. Encouraged by the performance of this well, four more of the same size and type were drilled in the same vicinity, varying in depth from 70 to 87 ft. The material encountered was a fine beach sand having an effective size of 0.18 mm. and a uniformity coefficient of 1.55. The wells were all located within an area of 650 ft. square, and it was assumed that while one well would probably yield 260,000 gal.

per day during the Exposition period, mutual interference would bring their combined capacity to about 2¾ times the capacity of one well, or 650,000 gal. per day for the five wells.

Filtration Plant. Considering shallowness of the wells and the possibility of contamination due to the water shed being inhabited, it was decided to filter the water and treat it with chlorine gas. Realizing that the plant would probably end its usefulness with the Exposition, a design was adopted in which first cost was the prime consideration. The elements of the plant consist of a measuring chamber into which the water is discharged from the wells and sump, a raw water

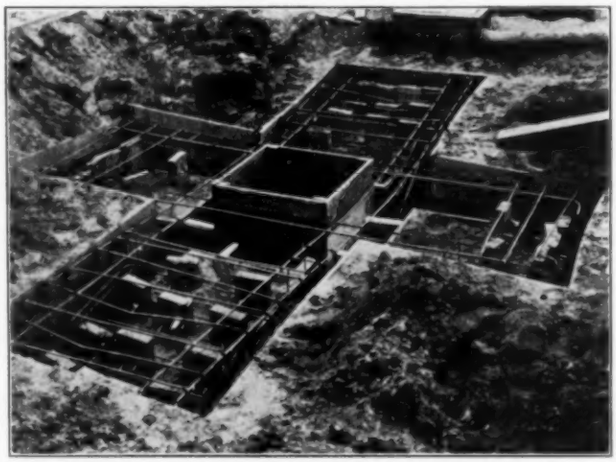


FIG. 24 FOOTING OF LAMP STANDARD, SHOWING REINFORCEMENT AND ANCHORAGE

reservoir where the coagulant is introduced, three rapid sand filters and a clear water reservoir. A uniform flume type construction was used for all elements, the adoption of which simplified the framing, foundations and erection. A bulkhead placed near one of the raw water reservoirs forms a measuring chamber 12 ft. 6 in. by 9 ft. 6 in. by 9 ft. 3 in. deep. Two 4-in. by 12-in. submerged orifices are located in this bulkhead. The supply lines from the sump and wells discharge into this chamber and are fitted with control valves actuated by floats located in the raw water reservoir. A differential gauge indicates the difference in levels between the water surfaces in the measuring chamber and raw water reservoir, from which the rate of flow is determined.

The raw water reservoir is 64 ft. long by 12 ft. 6 in. wide and 8 ft. deep, its size having been determined by the period of time required for coagulation with four filters operating at maximum rate. The treated water flows from this reservoir to the filters through a 2-ft. by 3-ft. flume located between the row of filters. The supply to each filter is controlled by a shear valve located in the side of the flume. At the far end of the flume is an overflow weir which comes into use in case the water level in the raw water reservoir exceeds the predetermined height.

Three filters, each rated at 500,000 gal. per day, are in operation, but space and pipe connections are available for a fourth unit should the necessity arise. The units are 14 ft. 8 in. long, 12 ft. 6 in. wide and 8 ft. deep. The collector system employed is a departure from the usual types and has been most successful in operation. The design was developed by Prof. Charles Gilman Hyde, and in addition to its effectiveness has the merit of low first cost. The collector in each filter consists of a header, rectangular in section, bolted to the bottom of the filter. The effluent pipe is run through the bottom of the filter to the center of the header from which point the header is tapered so that the loss in head is fairly uniform throughout its length.

On the top of the header, openings are provided for the 3-in. nipples which make the connection to the 2½-in. lateral pipe. These laterals are placed on 6-in. centers and extend the full width of the filter. Holes $^{5}/_{16}$ in. in diameter and 3 in. apart are located on the under side of the laterals. The loss of head through each of these small holes being the same, and great as compared with the losses elsewhere, insures a uniform collection of the effluent. Coarse gravel was placed in the bottom of the filter to a point 2 in. above the laterals, then three layers of graded gravel, each 3 in. thick, followed by 26 in. of sand having an effective size of 0.35 mm. and a uniform coefficient of 1.5.

The depth of water over the top of the sand is 30 in. The effluent flows from each filter through an 8-in. riveted steel

FIG. 25 BANNER TYPE LIGHTING STANDARD

pipe to the clear water reservoir, where an effluent controller of simple design is installed. The controller is set in a compartment located within the clear water reservoir with water connection thereto through a submerged weir. The level of the water in this compartment is kept at a constant height by a float actuating the controller, which insures a fairly constant rate of flow. Should the water in the clear water reservoir reach the overflow point, an auxiliary float closes the effluent controller. Wooden floats are used throughout and the simplicity of the effluent controller may be realized by the fact that three of them, 8 in. in size, cost less than $50 to make. All of the measuring or controlling

devices used in this installation are home made, and while some of the equipment may appear to be crude it does the work with all of the accuracy essential to operation.

The washing of the filters is done by the reverse current method, the water being forced through the collector system at a high velocity. A 10-in. centrifugal pump is used for this purpose and the rate of washing is 2-ft. vertical rise per min. in the filter, which is equivalent to 15 gal. per min. per sq. ft. of sand surface. Washing at this rate raises the sand bodily about 12 in. and keeps it in motion. Two wooden V-troughs in each filter collect the wash water. No appreciable disturbance of the gravel has been noted, although no means have been provided to prevent it. It takes about 5 min. to wash a filter, the wash water being applied for 2 min. Owing to the water being practically free from turbidity, it is only necessary to wash the filters every 10 hours.

Clear Water Reservoir. The clear water reservoir is 96 ft. long, 12 ft. 6 in. wide and 7 ft. 6 in. deep and holds 60,000 gal. of water. From the bottom of this reservoir, and located on the side directly opposite that on which the effluent controllers are situated, three 6-in. suction pipes are run, one to each of the three units in the main pumping plant. Over that part of the reservoir where the controllers are installed is a house which contains the sterilizing equipment.

This equipment is the exhibit of the Electro Bleaching Gas Company, of New York, and consists of a gauge board, shut-off valves, gauges and a pressure reducing valve. The quantity of gas applied is indicated by the position of a small glass float located within a tube.

The apparatus is easy of adjustment and does not require a skilled attendant. In order to keep a check on the quantity of chlorine used, the cylinder in use is kept on a platform scale, and it has been found that the quantity determined from the gauge readings checks within 1 per cent of the weighed quantity. The chlorine is applied at the rate of 3 lb. per 1,000,000 gal. of water, and bacteriological tests have demonstrated that the water is at all times perfectly safe for drinking purposes.

Main Pumping Plant. The water is taken from the clear water reservoir and pumped to the Presidio reservoir by three 5-stage 6-in. centrifugal pumps, each rated at 500 gal. per min. against a pressure of 220 lb. These pumps are belt driven by 125-h.p. induction motors. The pump house is located alongside of and about 5 ft. lower than the clear water reservoir, so that the pump suction lines are under a pressure head at all times. The main pumps force the water through a 12-in. main to the Presidio reservoir, which is 19,300 ft. from and 365 ft. above the pumping plant.

FIG. 26 COURT OF FOUR SEASONS, WITH SCINTILLATOR IN DISTANCE

Trouble with Wells. While no trouble has ever been experienced with the test well mentioned heretofore, the other four wells gave trouble from the start. It is hard to explain this difference, as the wells were all of identical construction and the formation encountered was the same for all. The pumps used in these five wells are vertical, 3-stage, centrifugal pumps, belt-driven by 20-h.p. motors, and operate at 1400 r.p.m. against a 75-ft. head. A foot valve was placed below the pump, but as it was the cause of the pump becoming choked with sand it was discarded and a check valve placed in the discharge line from the pump. Each of the wells in turn started to sand up as soon as any considerable amount of water was pumped, with the result that the pump soon choked and it became necessary to withdraw the pump and sand-pump the well.

Although the pumps were supposed to be adapted for

handling water containing sand, the bronze bearing bushings were in some instances cut out with one day's operation. This trouble was largely overcome by discarding the tubes which enclosed the shafting, and using leather rings above and below each bushing, securely fastened thereto and fitting snugly on the shafting. By operating the pumps at capacities between 60 and 100 gal. per min., depending upon the well, continuous flow could be obtained, but a certain amount

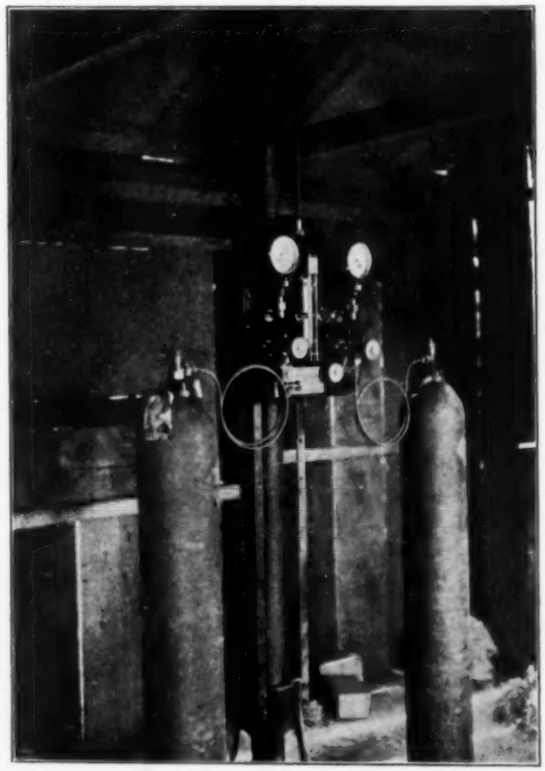


FIG. 27 APPARATUS FOR APPLYING CHLORINE TREATMENT TO WATER SUPPLY

of sand would be discharged and the wells would soon fill up with sand. In order to avoid the expense and delay incident to removing the pumps and sand-bailing the wells, an air ejector was made which could be lowered into a well without disturbing the pump. By this means 50 ft. of sand was taken out in 3 hours, a large part of the time being consumed in putting down and removing the piping. The removal of such large quantities of sand soon caused the ground around the casing to cave, with resulting disturbance to the foundations of the building and equipment.

It became evident that the wells as they stood would never give satisfaction, and it was decided that their failure was due to the size of the gravel which had been placed in the annular space between the outside and inside casings. In the belief that a suitable material could be found which would keep the sand out and at the same time allow the water to flow through freely, it was decided to experiment with various mixtures of sand and gravel and different perforations for casings.

Flat test plates 8 in. by 12 in. were prepared, each having a different size of perforation. These were tested by placing them in a wooden frame box with trial mixtures of sand and gravel placed between the plates. Above the plates a quantity of the sand was placed that had been taken out of the wells, and water pressure applied. The flow of water was measured by meter and the pressures taken for different rates of flow. The result of these experiments was the selection of a naturally graded beach sand which had an effective size of 0.42 mm. and a uniformity coefficient of 2.18. It was determined that, with the use of this, sand plates could be used having a perforation of $^{1}/_{32}$ in. in width, and that the fine material from the wells would be held back even when the velocity through the perforations was as high as 0.75 ft. per sec. As the maximum velocity through the perforations under operating conditions would never exceed 0.5 ft. per second, it was considered safe to use this material.

As the wells, except No. 1, were not giving more than half the yield contemplated, it was decided to put down additional wells, making use of the data which resulted from the experiments. The contractor's price for the old wells was $7.50 per ft., and it appeared that new wells could be put down cheaper with the Exposition's force by using a hydraulic ejector instead of a well driller's standard equipment. The site chosen for the trial well was close to the main pipe line where water would be available at 175-lb. pressure. The hydraulic ejector or sand-pump was made with standard fittings, but had a machined brass throat piece. The well drilling rig and ejector are shown in the illustrations.

In starting, the bottom section was made up of a 5-ft.

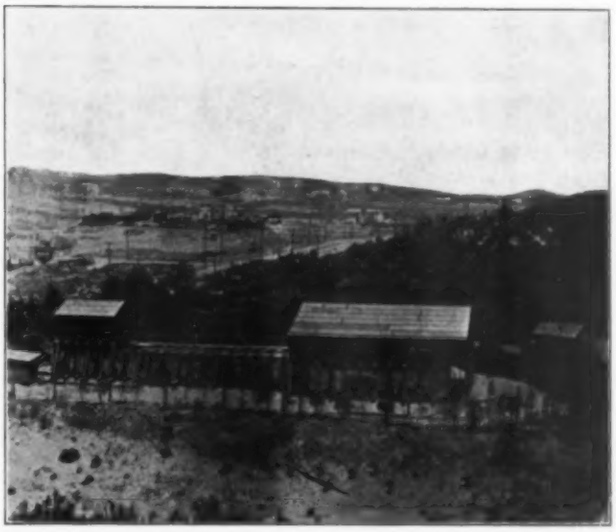


FIG. 28 FILTRATION PLANT. FILTER HOUSE IN FOREGROUND

length of inner and outer casing, the inner casing being tapered to the diameter of the outer at the bottom and both riveted to a forged steel shoe. A hole was dug 5 ft. deep at which point water was encountered, and the bottom section set in place. The hydraulic ejector was placed inside and excavated the material down to the shoe. The first 15 ft. of casing went down of its own weight very rapidly, but for the balance of the distance it had to be forced down by means of the long lever shown. The maximum force applied was about five tons and the average rate of travel of the casing was 1 in. per min.

After 25 ft. of casing had been placed it was found that the well was badly out of line due to the removal of too much

material from one side. The casing was straightened up by putting a jet down one side and keeping a strain on the top of the casing by means of block and tackle. Guides were put on the ejector suction to keep it centrally located, and no further trouble was experienced with the casing getting out of line.

It required five days to complete the well to a depth of 60 ft. The outer casing used for this well was 22 in. in diameter, No. 12 gauge steel, with collar joints, each section being

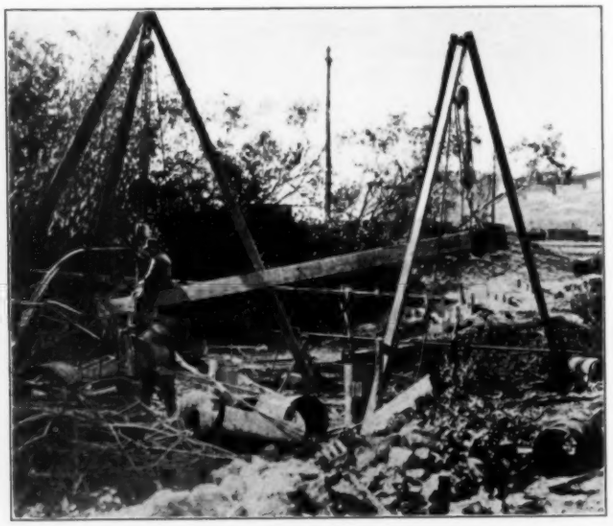


FIG. 29 RIG USED FOR DRILLING NO. 6 WELL

30 in. long, with perforations $^1/_{16}$ in. wide by 1¾ in. long. The inner casing was 16 in. in diameter, of similar construction, but with perforations $^1/_{32}$ in. wide. The area of the perforations was estimated at 0.0329 sq. ft. per running foot of pipe. Perforated casing was used throughout the depth of the well except for the bottom section and the upper five sections. The material used in the annular space between the inner and outer casings was that determined by experiment, and was put in place as the casing was lowered.

The well, on test, developed a capacity of 200 gal. per min. without discharging sand. Instead of drilling additional wells of this type, which would take time and involve additional pumping equipment, it was decided to reconstruct all of the other wells, except No. 1.

Efforts to remove the inside casing met with no success. Fortunately, the diameter of the deep well pumps was such as would allow the placing of a 13½-in. casing inside the well. One of the wells was equipped with this size of perforated casing, and the space between it and the 16-in. casing was filled with the same grade material as that used in the No. 6 well. The installation of this casing was a comparatively simple matter and required about eight hours' work for an 80-ft. well. Under test the remodeled well operated continuously at a rate of 243 gal. per min., and no sand appeared in the discharge. The use of the additional casing and the sand increased the resistance to the flow of the water, and for the same yield the water surface had to be drawn down about 30 per cent lower than before. The rest of the wells were reconstructed in a similar way, and have all been brought up to capacity, without trouble from sand.

Other Sources of Supply. In October, 1913, three wells were sunk in the grounds which were of considerable use during the construction period, but owing to the questionable character of the water from a sanitary viewpoint these wells are no longer used, except for filling pools. Water is also taken from the Spring Valley Water Company for the Fisheries exhibits and to supply an occasional shortage.

Amounts of Water Used. Below is given a table showing the quantities of water used and the sources of supply from February 20 to July 31, inclusive:

Month	Government water	Park water	Spring Valley water	Zone wells	Total (gal.)
Feb. 20-28.....	723,937	.....	226,775	204,000	1,337,500
March.....	733,523	347,290	106,990	34,703	1,228,965
April.....	724,270	591,760	29,593	.....	1,345,617
May.....	612,887	564,636	19,116	.....	1,205,636
June.....	473,057	1,057,730	54,910	.....	1,585,694
July.....	398,460	1,060,094	138,696	.....	1,597,250

It will be noted that the supply obtained from the Presidio fell far short of the estimated amount, 800,000 gal. per day, and that the Golden Gate Park supply has been increased materially over the assumed yield of 1,000,000 gal. per day.

FIG. 30 PERFORATED WELL CASING AND HYDRAULIC EJECTOR

Additional wells in the vicinity of the park are being developed which will probably contribute 500,000 gal. per day to care for the increased consumption to be expected in August and September, and offset a possible decrease in the yield of the old wells.

The maximum draft noted at any time shows that water was being used for short periods at the rate of 4,250,000 gal.

per day. On average week days 60 per cent of the total consumption is used between the hours of 8.00 a.m. and 4.00 p.m., and on Sundays (when there is no irrigation) about 47 per cent during these hours.

Cost of Water. The cost of water per 1000 gal. from the Golden Gate Park plant is 1.517 cents for pumping from the deep wells to the filters, 0.974 cents for filtering and treating with chlorine, and 3.935 cents for pumping to the Presidio reservoir, making a total cost of 6.426 cents per 1000 gal. delivered in storage. These costs cover operation and maintenance only. The water obtained from the Presidio is sold to the Exposition for $7\frac{1}{2}$ cents per 1000 gal., while that taken from the Spring Valley Company averages $19\frac{1}{2}$ cents per 1000 gal.

Quality of Water. Tests of the water from Golden Gate Park are made weekly by the Federal Laboratory, and in no instance has the treated water failed to meet the U. S. Government requirements for potable water. The following is a representative test:

Raw Water.....	Gas in 10 c.c., colon types count, 100 per c.c.
Effluent.....	Gas in none of the specimens Count, 12 per c.c.

Construction Costs. The filtration plant, including the pump houses for the main pumps and wells, together with the pipe line to the wells, cost $14,575. The cost of the first five wells was $3,075 and that of the No. 6 well $255. The cost of the sump was $14,979. The pumps, which included three 5-stage main pumps, one 4-in. vertical centrifugal sump pump, five 6-in. deep well pumps, and one 10-in. wash water pump, cost $4,962. The electrical equipment was rented. The cost of the pipe line from the pumping plant to the Presidio reservoir, and from the Presidio reservoir to the Exposition grounds, was $37,150. The total expenditure to develop a water supply and deliver it to the Exposition grounds was $77,000.

TELEPHONE SYSTEM

One of the important activities of the Exposition is the operation of the telephone system within the grounds. An arrangement was made with the local telephone company, whereby the necessary equipment was rented to the Exposition and the latter installed the distribution system. An 18-position switchboard was installed in the Food Products building, at which point the trunk lines from the local company were terminated. In laying out the distribution system, the grounds were divided into sections and cables run to the approximate center of each. Cross connection boxes were installed at these points, from which feeder cables were run where required. The conduit system installed for the electric distribution was also used for the underground telephone cables.

In the buildings twisted pairs were run in rings along roof trusses or under the floors, while in the Zone district the subscribers were connected to a cable fastened to the fences in the rear of the concessions. In the States and Foreign sites cables were run to a few of the large buildings, and feeder cables from these points to other buildings. The underground distribution system required the installation of 47,700 ft. of cable (9,474,800 ft. of wire), of which 4300 ft. was 400-pair cable. Over 1,100,000 ft. of duplex wire was used in the overhead distribution.

With the view of facilitating the work of the Exposition's forces, private branch exchanges were installed in a number of the large departments. These exchanges had interconnecting lines in addition to direct lines to the main board and to one of the exchanges of the telephone company, the latter line being used only for outgoing calls. Fifteen attended pay stations with 100 booths were installed, one in each of the main buildings, three on the Zone and two at the entrances. These were later changed to non-attended stations as the income did not warrant the expense of attendants.

In addition to the foregoing, 53 telephones with coin collectors were installed at convenient points around the grounds. The Exposition installed 732 telephones for its own use and 1244 for the needs of its subscribers and pay stations. Subscribers are charged on the basis of the equipment required, the charge for a 1-party station being $6 per month. All services are metered and the rates for calls terminating within the City vary from 5 cents to $3\frac{1}{2}$ cents each, depending upon the number used by the subscriber in any one month.

No one element of the organization contributed more to the successful opening of the Exposition on time than did the telephone department. The demands upon the telephone system around opening day were unprecedented, the number of calls handled per day reaching 49,500.

CONCLUSION

The president of the Exposition, Mr. Chas. C. Moore, has been identified with many successful engineering enterprises, and when he undertook the responsibility of this great project he selected an engineer for the position of Director of Works. At previous expositions the Director of Works had always been an architect, and there was much criticism over the appointment of an engineer for this position, but the choice has been fully justified by the artistic results obtained and the completion of the Exposition on time and within the amount appropriated, a performance not usually associated with the construction of expositions or other monumental groups of buildings. There was some fear that with engineers in charge, whose efforts might be expected to be in the direction of keeping the costs within the allowances, there would be decisions which would seriously affect the aesthetic value of the various decorative features, and would stifle the zeal of the architects, sculptors and artists. But while the designers had their heads in the air, the engineers had their feet on the ground and many features were changed or eliminated to keep the expenditures within limits. These changes were made without friction, as the engineers were appreciative of the efforts of the architects, sculptors and artists and thereby secured their assistance toward the desired end.

The Exposition engineers have had an unusual opportunity not only to carry out their ideas in matters of construction, but to manage the operation of a great enterprise. Investigation will show, in this instance, the versatility of the engineer and his fitness by training and temperament to analyze a situation and to foresee difficulties and provide against them.

MECHANICAL ENGINEERING AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

BY G. W. DICKIE, SAN FRANCISCO, CAL.

Vice-President of the Society

THE Panama-Pacific International Exposition shows very clearly the changes during the past 22 years, or since the Columbian Exposition, particularly in mechanical engineering. At the lake front of the Chicago Exposition, there was a full-sized model of the first three battleships then building for the U. S. Navy. This model was built of bricks and concrete on piles, and in it the Navy Department had a very instructive exhibit. To-day the actual battleship, thus portrayed on Lake Michigan, lies in front of our Exposition as an illustration of a type now passing away, but with a twenty years' history to think of, of which the model on the lake shore gave no intimation.

The first thing that the mechanical engineer observes on entering the Palace of Machinery at the Panama-Pacific International Exposition is the entire absence of the steam engine. There is not a steam engine of any kind in operation, nor a steam boiler under steam. This is the first international exposition where the steam engine, as a prime mover, has been so conspicuous by its absence. On first thought the engineer might take this as evidence that the steam engine, after a century or more of development and a service to industry beyond reckoning, had suddenly reached a stage of innocuous desuetude and had ceased to rank as the greatest machine that the mechanical arts had produced. On second thought, however, he would have to admit that, of all the power developed by the combustion of fuel, more than 90 per cent is developed in the cylinders of steam engines or the rotors of steam turbines. His third thought would probably bring him to the conclusion that the steam engine, in all its varied forms, has reached that stage of development when no striking improvements can be looked for; in fact, the steam engine has in a sense reached its prime, and may be expected to continue doing a large proportion of the work rendered possible by the combustion of fuel, either liquid or solid. The fact that California is a great fuel oil producing state may be one reason why the steam engine forms no part of the machinery exhibits; yet the great bulk of California oil used for fuel is consumed under steam boilers.

A striking feature of the mechanical engineering exhibits at the Panama-Pacific International Exposition is the entire absence of the steam engine.

In presenting his paper Mr. Dickie said that while the steam engine was advancing to the place it now occupies and many improvements were being made, the builder with something new was ready to show his best work at an exposition. This great prime mover has now reached maturity and will only take second place when the internal combustion engine has reached such a robust maturity as to enable it to do on a much smaller diet what our great steam engines are doing.

There is quite a large display of gas engines in the Palace of Machinery, the Transportation Palace, and the Palace of Agriculture. These engines may be classed as:

(*a*) *Marine Engines, Otto type, constant volume class,* for distillate fuels such as gasoline and kerosene. In this class there are some fine exhibits, such as the Standard Gas Engine Company's exhibit, showing a good line of well designed and carefully finished engines from 100 h.p. down to small sizes. The Union gas engine, shown cut open to illustrate the movements of piston and valve gear, is a fine type of marine gas engine. The Gas Engine and Power Company and C. L. Seabury Company show interesting examples of engines.

The Van Blerck Motor Company exhibit some handsome engines of attractive design, which present new features. The Imperial Gas Engine Company have an attractive exhibit of substantial-looking engines; while others in the same class, such as the Buffalo Gasoline Motor Company, the Wisconsin Machinery and Manufacturing Company, the Loew-Victor Engine Company and the Waterman Marine Company are all well worthy of study. This type of marine gas engine is well represented at the Exposition.

(*b*) *Marine engines, Otto type, constant volume class,* with injection for heavy oils. Of this type there is but one example, that of August Mietz. It is a well designed and strongly built engine.

(*c*) *Marine Diesel oil engines.* In this class there are two exhibits—that of the New London Ship and Engine Company and that of the Fulton Manufacturing Company. The first-named works under a load of about 80 per cent of full power, the normal power being 200 horsepower. These engines illustrate the present state of the art in Diesel engines of moderate power.

(*d*) *Stationary engines, Otto type, constant volume class,* for distillate fuels such as gasoline and kerosene. Of this class a great variety is shown, suitable for a wide range of work. Mention might be made of the exhibit of the International Harvester Company, which shows these engines designed for all purposes to which motors can be applied on the farm and all other rural work. There is a rich field in this exhibit, which gives information as to the best way to hitch up a gas engine to almost any kind of work.

The Western Gas Engine Corporation exhibits stationary gas engines which present some features worthy of study. These engines have an unusually long stroke for gas engines, and were the first to introduce water into the carburetor. The valve gear is very simple, with free-moving parts operated by a rod from a single eccentric.

Presented at the Panama-Pacific International Exposition Meeting, of the Society, San Francisco, September 1915. The paper may be obtained in pamphlet form; 15 cents to members, 30 cents to non-members.

The Doak Gas Engine Company and the Bessemer Gas Engine Company show some good work under this class. The Standard Gas Engine Company's exhibit is also well worthy of attention.

(*e*) *Stationary engines, Otto type, constant volume class,* with injection for heavy oils. Under this type some very good exhibits are shown, notably those by August Mietz and the Bessemer Gas Engine Company.

(*f*) *Stationary engines, Otto type, constant volume class,* for gaseous fuels. In this class there are two exhibitors, the Standard Gas Engine Company and the Western Gas Engine Corporation. As the arrangements of valve gear, etc., of these engines are quite different in design and function, they offer a good opportunity for comparison.

(*g*) *Stationary Diesel oil engines.* In this class there are two exhibitors, the Busch-Sulzer Bros. Diesel Engine Company and the McIntosh and Seymour Corporation. Both show fine examples of vertical engines of 500 h.p. each and both illustrate the best that these makers produce. Each engine is operating with Star distillate, which is probably the nearest to California crude oil with which it is safe to work these engines.

In the special types of gas engines or motors shown in the Transportation building, a large and varied display illustrating their application to automobiles, motor trucks and motor cycles, gives ample opportunity for study in this interesting field. The beautiful workmanship on many of these show the taste and skill that has been brought to bear upon the development of this immense industry.

California is not only rich in liquid fuel, making it an ideal home for the internal combustion engine, but the whole Pacific Coast is a land of liquid power, ready to be used without the necessity of burning anything to produce it. The winter snows on the high Sierras and other mountain ranges forming the eastern boundary of the Pacific slope are the source of this vast accumulation of stored-up energy, which, in the past thirty years or so, has been more and more converted into electrical energy and carried for hundreds of miles to the points where it is needed, to operate factories and street cars, light cities, warm houses and cook food. It is not surprising, therefore, that the most impressive exhibit in the Machinery Palace should be that of the Pelton Water Wheel Company. The writer felt his inability to do justice to this splendid example and asked help from W. A. Doble, chief engineer of the Pelton Water Wheel Company and the designer of much of the display made, who kindly furnished a description from which the following is taken:

It being impossible to secure water, either in sufficient quantity or under pressure desirable for driving hydraulic prime movers, an effective combination of turbine pumps, drawing water from a common sump, and discharging, through control devices and pipe lines of the types customarily employed in hydroelectric practice, into water wheels of both the tangential and turbine types using the sump as a tail race, has been worked out.

The operating division consists of two sections:

a A high head pumping project combined with a high head hydroelectric development where water economy is important, and employing tangential water wheels.

b A deep well pumping project combined with a medium head hydroelectric development, employing mixed flow turbines.

The high head pumping plant consists of a Pelton-Doble turbine pump, driven through a flexible coupling and herringbone speed-increasing gears by an internal combustion engine. The high speed shaft of these gears turns at 1800 r.p.m., the efficiency of transmission at full rated load of 150 h.p. being in excess of 98 per cent.

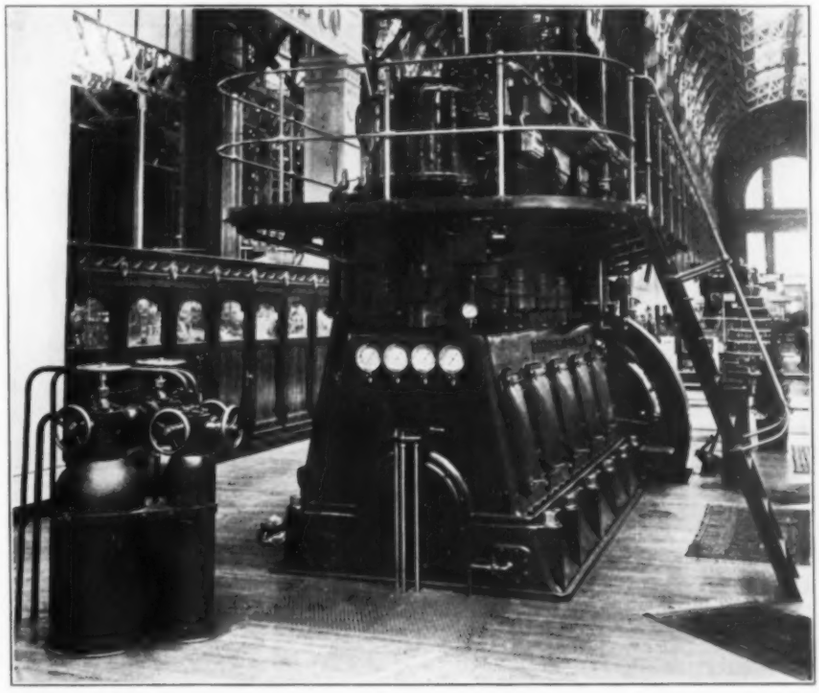


FIG. 1 500-H.P. DIESEL ENGINE EXHIBITED BY BUSCH-SULZER BROS. DIESEL ENGINE CO.

The engine is a 6-cylinder vertical type, developing 180 h.p. at 350 r.p.m. It uses heavy oil up to 18 deg. Beaumé for fuel and operates on the 4-stroke cycle with maximum compression not exceeding 450 lb. per sq. in. No ignition difficulties are experienced with this low compression.

The pump is a single stage uni-diffusion type, having a capacity of 1100 gal. per min. against a head of 300 ft. The discharge line, after passing through an 8- and 6-in. venturi ring, connects to a Pelton-Doble tangential unit, rated at 100 h.p. under 300 ft. head and operating at 300 r.p.m. This unit is of the single overhung, two-bearing type, with the armature of a 75-kw., 250-volt engine-type direct current generator carried between the bearings, and a flywheel overhung on the shaft end opposite the tangential runner.

Water from the high-pressure pump is applied through a needle nozzle, governing being accomplished by an oil pressure type governor mounted on the nozzle casting, and actuating the needle directly through suitable link and rockshaft connections. An auxiliary relief needle nozzle avoids

excessive pressure rise in the pipe line and minimizes water waste during governing cycle. The needle of this nozzle is connected to a spring-controlled oil cylinder, known as the cascade cylinder. Ports, adjustable from the outside of the cylinder, determine the time element of piston travel. The same link and rockshaft system that actuates the main needle nozzle is connected to the piston of the cascade cylinder, the relative motion (and thus the nozzle area) being equal and opposite in direction when the time element of the cascade cylinder is zero. With this setting, the auxiliary nozzle merely acts as a synchronous bypass, and the water quantity is constant. Where water economy is of importance, the time element of the cascade cylinder is so adjusted that a rate of closing of the main needle which does not raise the surge pressure to a dangerous point will not open the auxiliary needle. Higher closing rate opens the auxiliary needle, which is then returned to closed position by the compression springs of the cylinder mounting at a rate that will not cause dangerous surge pressures. This is the position of maximum economy.

The deep well pumping plant consists of a Pelton-Doble bore-well type turbine pump, with a capacity of 4500 gal. per min. against a head of 60 ft. and driven at 1760 r.p.m. by a vertical motor mounted on the pump pedestal. The maximum diameter of the pump is 22½ in., permitting its easy entrance into a 24-in. bored well.

The discharge orifice has a diameter of 14 in., and has, bolted directly to it, a riveted steel pipe line which leads to a Pelton-Francis turbine. A venturi ring, 18 in. in diameter, is set in this line. This unit operates under a head of 50 ft. and develops 50 h.p. at 1400 r.p.m., an unusually high specific speed.

The entire operating division is arranged for laboratory investigations, and more than 800 tests have been conducted by independent engineers and the staff of the Pelton Water Wheel Company. During the autumn semester of the local universities, 1915, additional tests will be conducted by senior students of the engineering departments.

The central feature of the entire exhibit is a Pelton-Doble single, overhung-runner, single-discharge turbine, rated at 20,000 h.p. under 500 ft. head, at 360 r.p.m. The entrance valve, casing, draft tube and governor are assembled complete; the runner, of bronze with steel hub and forged wearing rings, and fitted with leakage evacuators, is displayed on a separate pedestal. The main valve, of the butterfly type, is 66 in. internal diameter, with body of annealed cast steel.

Two runners, each rated at 10,000 h.p. under 1350 ft. head at 360 r.p.m., are displayed. These are of the chain connected type, with ellipsoidal cast steel buckets. The jets for these units are 7 in. diameter, and are projected from deflecting needle nozzles with motor operated manual controlled needles and governor controlled deflection. One of these nozzles, assembled complete with motor, and three needles, pedestal mounted, are displayed. A single bucket of the chain connected type, taken from a wheel rated at 14,000 h.p. under 870 ft. head at 200 r.p.m., is also displayed. A number of water motors of standard and special design complete the tangential section.

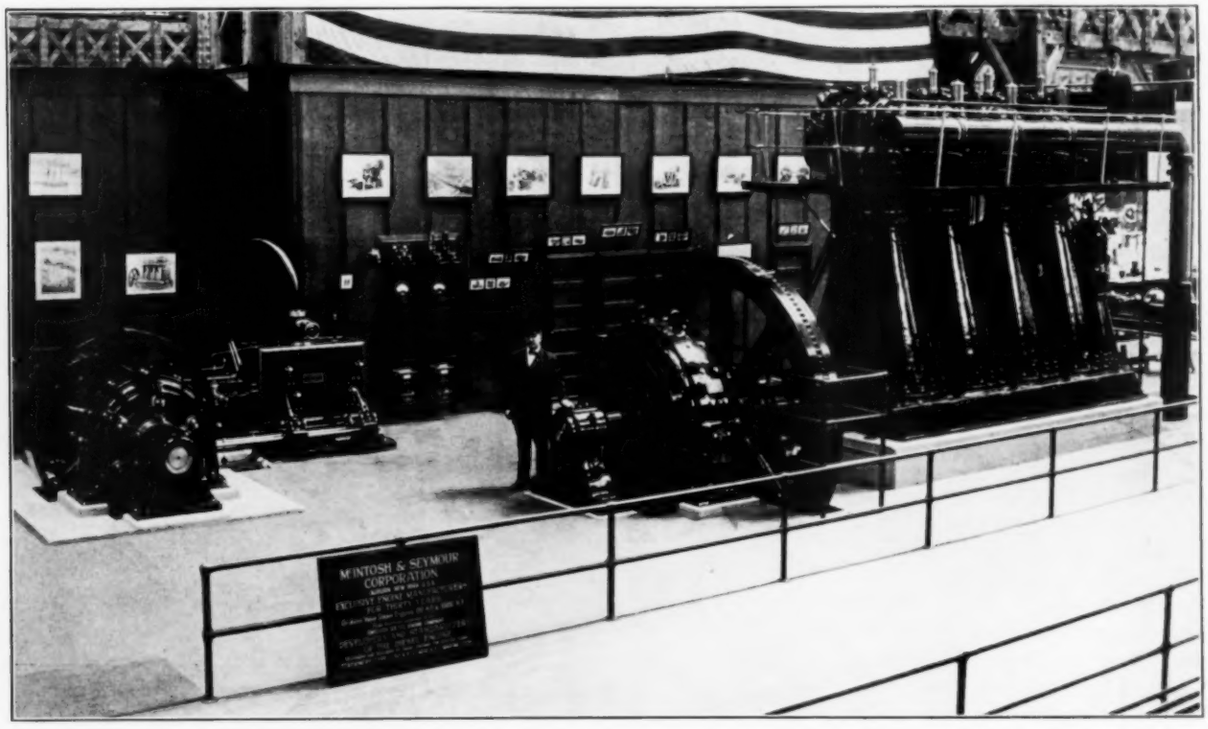


FIG. 2 500-H.P. DIESEL ENGINE EXHIBITED BY McINTOSH AND SEYMOUR CORPORATION

In the governor section are displayed a group of self-contained oil pressure type governors, of 5000 ft.-lb. drawbar effort, and, in conjunction with a standard mounted tangential unit, an enclosed type of oil pressure governor having a drawbar effort of 80 lb.

The exhibits of machine tools are not very numerous and, outside of two very notable exhibits, there is nothing in this

line that requires the attention and study of the mechanical engineer who has a fair knowledge of the modern machine tool. Before examining the machine tools it would be well to inspect the exhibit of the Tinius Olsen Testing Machine Company as the records produced by such machines form the foundation work for all modern machine tool design. The mechanical engineer finds in this exhibit, which is probably the best in its class that has ever been exhibited by one maker, much food for thought and many admirable ideas in design.

Testing machines and apparatus for engineering research and development may be arranged in two main groups: *a* Apparatus and machines for testing structural materials in the form of specimens, as well as the testing of complete designs and structures. *b* Apparatus and machines for testing the materials from which tools are to be made, as well as testing the finished tools.

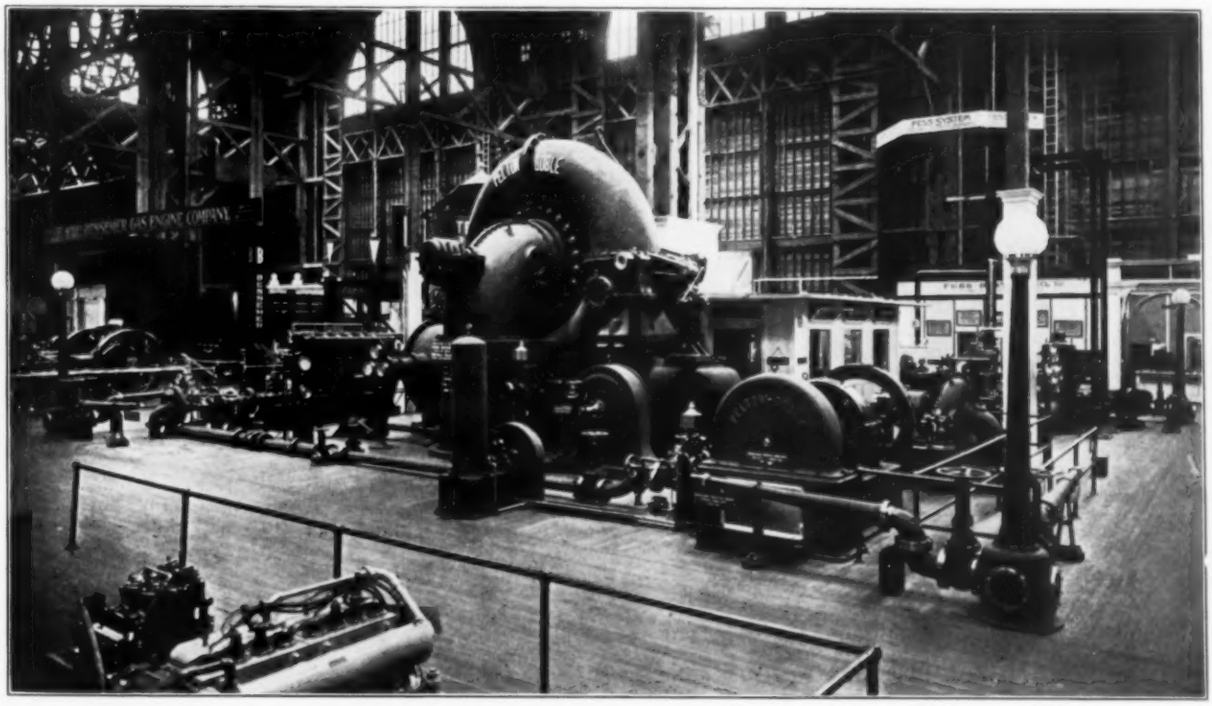


Fig. 3 Pelton Water Wheel Co.'s Exhibit, Showing 20,000-h.p. Pelton-Doble Turbine

In the United States prior to 1870, very little progress was made in apparatus for ascertaining the actual strength of materials. One device may be mentioned as used by the U. S. Board of Ordnance for testing the cast iron used in gun making. We know also of one hydraulic press used by Captain Eads for testing the members of the first bridge over the Mississippi River. About 1870, the U. S. Government established the Bureau of Boiler Inspection in connection with the U. S. Steamboat Inspection Service. This bureau formulated rules which required that all boiler plates should be tested by having a cupon from each plate subjected to tensile strain for determining the breaking strain, as well as the yielding point or elastic limit, also the reduction of area at the breaking point and the elongation between two points. Hence came the inquiry for and the development of the commercial testing machine.

The first machine of 40,000 lb. capacity was designed and built by Mr. Olsen for boiler plate manufacturers. Soon after, about 1870, he built ten such machines for the different branches of the Boiler Inspection Service. Following this development, the technical and engineering schools began to install such machinery. One of the first—if not the very first—was bought from Mr. Olsen by Dr. R. H. Thurston for the Stevens Institute of Technology, Hoboken, N. J.

As time passed the testing machine was changed in design and improved and put to more constant and varied use by all manufacturers of structural materials, as well as large users, and also in technical schools, where its use developed laboratories with apparatus of larger and more diversified forms and functions to include investigation of the more varied character and direction of stress to which materials are subjected in modern design .

In group *b* are classed what are termed efficiency testing machines. These machines are of more recent development, although a simple machine of this class was shown at the Centennial Exposition, 1876, in a file manufacturer's exhibit; it was probably made by him to demonstrate the most efficient method of file cutting, as well as the most reliable material for file making and the best method of tempering. Nothing more was publicly shown in this line until a few years ago, when Edward Herbert of Manchester, England, placed on the market his file testing machine and a little later his machine for testing the efficiency of tool steels, especially modern high speed steels. A few of these machines are in use in this country. These two English machines are shown in Mr. Olsen's exhibit at the Exposition.

A few years ago, Mr. Olsen was called upon to design a machine for testing the efficiency of drills, taps and dies. About two years ago this was worked into a practical machine for the Philadelphia Navy Yard and has proved satisfactory, filling all the requirements for this purpose. Later,

by additional attachments, this machine has been perfected so as to make a universal tool as well as a tool steel testing machine. This machine in its newest form is shown in the Olsen exhibit; it will test tool steel, lathe and planer tools, milling cutters, drills, taps, dies, rimers, files, and hack saws, thus forming a practical efficiency testing machine for determining the quality of most tools as well as the most effective way to make and use them.

The Olsen exhibit is well worth a careful study by the mechanical engineer. Mr. Olsen himself is usually at the exhibit and he looks upon this fascinating collection of testing machines as his own children. As he knows all their little weaknesses as well as their good qualities, an hour's conversation with him is a liberal education in this subject. Here the observer will find the universal testing machine and instruments, spring testing apparatus, cement, concrete and road material testing machinery; cloth, yarn, paper, rubber and leather testing machines; oil testing machines, transverse testing machines, and special testing machines including im-

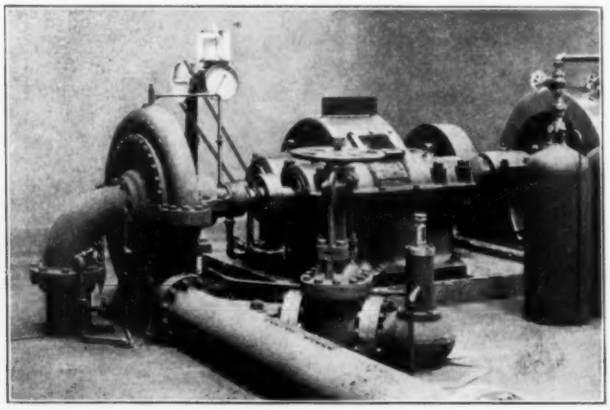


FIG. 4 CENTRIFUGAL PUMP AND HIGH SPEED TRANSMISSION. PELTON WATER WHEEL CO.'S EXHIBIT

pact, indentation, vibration, bending, hardness, endurance, torsion, and efficiency testing.

It is unfortunate that some of the largest machine tool makers of this country who had reserved a large amount of space in the Machinery Palace should have withdrawn from participation in the Exposition on the outbreak of war in Europe under the impression that the Exposition could not be a success under the conditions. This is to be regretted, as it leaves a gap in a very important part of the machinery department that the mechanical engineer will not fail to observe. Nevertheless, there are some notable exceptions whose presence makes this condition much less felt than it would otherwise have been.

Among these exceptions the engineer will not fail to notice the splendid collection of both automatic and semi-automatic tools exhibited by the Warner and Swasey Company. This company shows ten tools, several of them being of new design; the tools are all shown in operation and are attracting the favorable criticism of our best mechanics. Their new universal turret lathes are powerful tools and have some remarkable features. Because of their superior strength and rigidity and the fact that each carriage with its independent feeds is able to operate simultaneously, the lathes are enabled to produce a very large amount of work. They have equal facilities for both bar and chucking work. They have geared heads with splash lubrication. As many as eleven cutters may be used in the turrets and carriages of these lathes, all cutting at the same time and in one set up.

The other tools exhibited by this company belong to their line of screw machines and plain turret lathes which are so well known as the product of the Warner and Swasey Co. and are all characterized by the same scientific design and careful workmanship. The automatic boring and tapping machine used by all the large manufacturers of steam and water fittings for boring, facing and threading their outlets, valves, and joints is also shown in operation. This machine finishes unions as fast as the operator can put them in the chuck and an average of 350 one-inch unions are turned out in a day of nine hours by this machine.

Another exhibit that has given character to the display of machine tools at the Exposition is that of the Morton Manufacturing Co. This is an exhibit of draw-cut shapers, traveling head planers and key-seating machines. The draw-cut type has been developed by this company and lends itself to heavy cutting to a remarkable degree. The whole stress of cutting draws the work solidly and directly against the face of the main casting of the machine and eliminates the stresses from the table rail or the upper bolts holding the table as in the usual type of shaper. The tool arm or ram is under tensile stress in cutting, which tends to reduce or eliminate vibration; when the ram or arm is in compression, the heavier the cut the greater the danger of vibration. One feature of this type of shaper or planer is the facility it offers of shaping to lines, as the latter are on the outside in view of the operator and are not broken or destroyed by the tool as it leaves the work. The tool beginning its work on the face next the operator, the lines on that face can be worked to very accurately as they are not broken or destroyed until cut out by the tool itself. This feature is of great value to the operator as well as the owner of the tool. There is an adjustable back bearing which forms a stop or abutment to the end of the vise when planing parallel with the jaws. With this stop it is only necessary to clamp the work sufficient to hold it as the thrust of the cut comes against the back bearer or stop. As the drawing or pulling cut overcomes vibration, it is possible to make forming tools to be used in these machines at a moderate cost. Rounding tools, either concave or convex, can be made of various radii for producing correct curves in finishing parts of connecting rods, etc. Cutters can also be used for machining parallel openings cutting down both sides at once. Being the originators of the draw-cut principle as applied to this class of machines, the makers have consistently followed up every indication offered by their extended use leading to further improvement in design and operating function.

In the collective exhibit of Fred. Ward and Sons there are shown some very good machine tools, notably those by the American Tool Works. The engine lathes shown are well constructed modern tools with easily adjusted feeds and with speeds especially adapted and designed for electric drive. They are capable of caring for the service demanded by the use of high-speed tool steels and, as demonstrated at work, are good machines for modern manufacturing or general shop use. A planer and a shaper of good design and strongly built are also shown. The radial drilling machines shown by the same company are of good design and well built; they are also well balanced, as shown by the absence of vibration

when working at high speeds; the speed changes are readily made and the tapping attachment is very good.

Gould and Eberhart exhibit a shaper of excellent design and workmanship adapted for heavy work. The arrangement for changing the length and position of stroke is very good. The motor that drives it has two speeds brought about by sliding the armature through the field of the motor which reduces the number of change wheels required in the gear box. The same firm shows a special gear cutter which cuts two blanks at the same time; this is a strong, well built machine with several features that should be of interest.

In the extensive exhibit of products made by the Crane Co. is a motor-driven pipe-threading machine having two unusual attachments—a quick centering rear chuck and compressed air cutting-off tools. The whole machine is well designed and strongly constructed, and on account of the two unusual devices referred to is of interest to those specializing in pipe work and fittings. This machine is made by the Crane Co. for its own establishments.

The Landis Tool Co. exhibits grinding machines of both universal and special application. The several machines are of high-class design, massive in character and fitted to produce a wide range of work. The excellent quality of their work shows the care displayed in the building of the machines and the arrangement of the exhibit shows the wide and varied application of these machines in the mechanic arts.

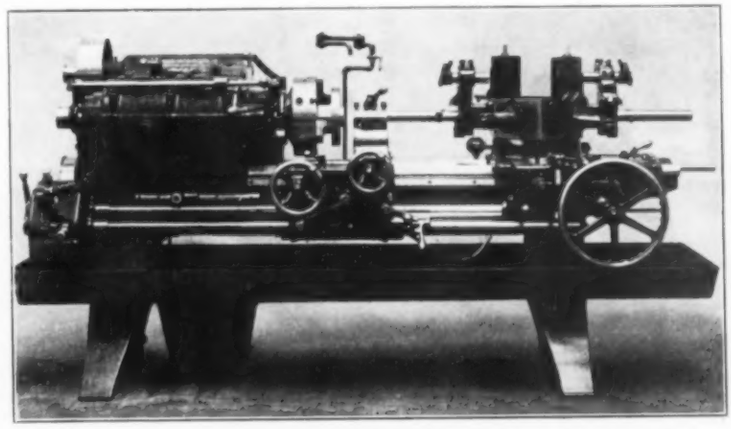


Fig. 6 Universal Hollow Hexagon Turret Lathe Exhibited by Warner and Swasey Co.

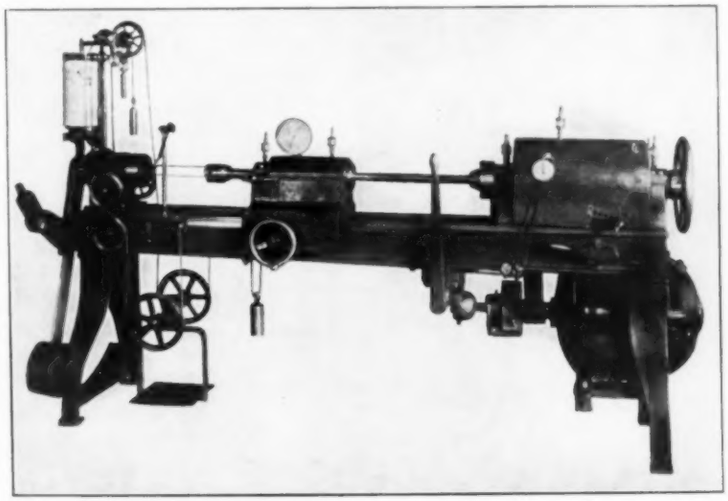


Fig. 5 Universal Efficiency Testing Machine. Tinius Olsen Testing Machine Co.'s Exhibit

There are a number of other metal cutting and shaping machines that attract attention in the Palace of Machinery and in the other buildings of this great Exposition; the engineer will discover them in places where he would never think of looking for such things, but on close inspection he will find that they are in some way connected with other things that belong in the place where he finds them. While the display of machine tools is, for reasons already explained, by no means complete, there is enough to dispel any anxiety in regard to the ability of the tool makers to meet all the requirements of the engineer for tools to produce anything within the compass of mechanics.

California being an extensive fruit growing state, much of that product must be shipped to other states and foreign countries either in wooden boxes or in tin cans and the machinery required to make these containers is of great interest. At the Exposition this class of machinery is well represented and merits a careful study by those interested in automatic machinery.

The William S. Doig Co. are pioneers in the manufacture of box making machines. Their exhibit contains a complete set of machines of wide range and application for labor saving in the making of boxes. A clever device shown in this exhibit is a machine for fastening two or more pieces of wood together edge to edge. On this machine a number of reels contain corrugated steel ribbons sharp on one edge; if the pieces to be fastened together are long enough to require, say, four fastenings then there are four reels. The strips to be fastened together are drawn in at one end and discharged at the other. The corrugated ribbons are drawn in at one side at right angles to the seam and are cut off in lengths of about $1\frac{1}{2}$ in. and driven into the wood across the seam making a solid joint. This machinery enables strips of any width to be combined to make sides and ends, bottoms and tops of boxes, and saves much lumber that would otherwise be wasted. One machine with two boys will work up 4000 to 5000 feet of lumber in a day.

At the George D. Parker exhibit two box making machines are shown, both new in design. One of these, the orange box machine, has now obtained a wide use in California. It is automatic and makes an orange box in four movements. Another machine which has just been perfected after seven years' experimenting is shown. This completes a box at one stroke or revolution. The ends and sides are pushed up from below by a ram to the proper place while the bottom is pushed in from the back of the machine; the nailing mechanism acts simultaneously on the bottom and sides, while a ram pushes the finished box out of the way of the material

coming up for the next box. This universal machine is highly ingenious in design, entirely automatic in operation, of large capacity and has great economic value.

At the Max Ams Machine Co.'s exhibit is a complete set of can making machinery, arranged in the order usually occupied in a large can making establishment and being a complete outfit for making sanitary and open-top cans. Much ingenuity and good workmanship is displayed in this company's exhibit.

In the E. W. Bliss Co.'s exhibit is a very complete operating exhibit of power metal working machinery illustrative of the high degree of perfection to which this class of machinery has attained. The sanitary can making equipment is almost entirely automatic. The design of the different presses and carriers shows great mechanical ability; the automatic actions are perfect in operation, displaying fine construction and accurate workmanship. The individual presses with semi-automatic attachments for the manufacture of various types of metal boxes and cans and the automatic threading machines show the same fine workmanship and precision of operation of the automatic working parts. To this equipment is attached an ingenious and effective can testing apparatus which charges each can with 40 lb. air pressure and passes it under water, immediately showing a bubble if there is a leak; this testing is continuous and its speed equals that of the machine delivering the cans.

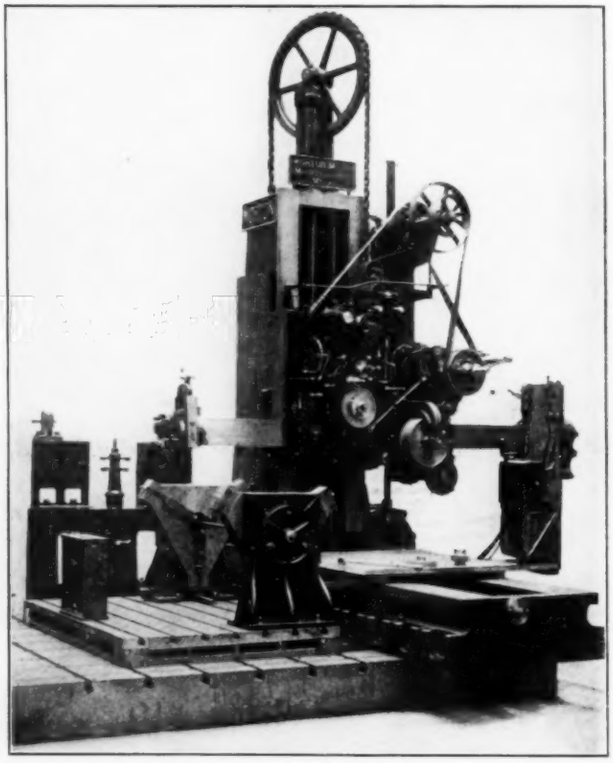


FIG. 7 CYLINDER PLANER EXHIBITED BY MORTON MFG. CO.

Also in the line of automatic machines, at the U. S. Army Ordnance Department exhibit is found a set of cartridge-making machines in operation; this comprises a very interesting set of machines that show the result of the long process of perfecting required in machines for delicate operations. To such an extent has this perfecting been carried out that some of these machines are arranged to remind the operator of his omission should he neglect to do his part. This demonstration is very interesting and instructive.

At the exhibit of the Carborundum Co. in the Palace of Machinery is shown an exceedingly high class exhibit of unusual educational value, extensive application of product, and instructive demonstration. The product of this company has revolutionized certain methods of manufacture, lowered costs and increased output. The application of the cutting wheels, cylinders, and discs extends from the cutting of the hardest crystals to the buffing of leather and cloth.

Illustrative of cutting metals by a flame cutter there are several exhibits of the oxy-acetylene cutting and welding equipments. The best exhibit is that of the Davis-Bournonville Co. in the Palace of Manufacturers as it shows a complete oxy-acetylene equipment including the apparatus for producing oxygen.

The fact that the Pacific Coast is a good market for saws, especially wood cutting saws, brought some good exhibits of that class of cutting tool to the Exposition, the most notable being the exhibit of Henry Disston and Sons, Inc. This firm shows a splendid collection of saws both for wood and metal cutting. The new forms of metal cutting saws with inserted teeth show the most advanced practice, the teeth being made of the newest grade of tool steel for high speed cutting in hard metals.

As he works his way through the Palace of Machinery, the mechanical engineer, if he be at all interested in the shaping of sheet metal, will stand for a while at the exhibit of the Dreis and Krump Manufacturing Co., who show a line of very well thought out brakes for bending metal plates. Three machines are shown, two being for light work, such as cornices or pilasters, adapted to all classes of straight line work, producing sheet metal boxes with right angle corners with great rapidity, and one for heavy steel plate, powerful in character and capable of bending to sharp angles plates $\frac{3}{8}$ in. thick and 12 ft. in length, this latter is a very original machine with well designed and strongly constructed steel working parts.

The Geometric Tool Co. in the Palace of Varied Industries exhibits tools for cutting external and internal threads, interesting on account of the fine and accurate workmanship and ingenious design displayed. The head for external threads opens automatically as soon as the length of thread for which it is set has been cut. For internal threads, the taps automatically collapse at the points for which they have been set. In each case, when the thread is finished the chasers do not return over the threads on the reversing of the tool. These tools can be used in any screw machine or turret lathe and show a decided advance in tools of everyday use.

The exhibit of the Hydraulic Press Manufacturing Co. is an extensive display of presses including pumps, valves, etc., for the manufacture of cider, olive oil, etc., and for filtering the same. There are shown also presses for bending or straightening metal bars, pressing car wheels on to axles and other similar lines of work.

Among small tools are those shown by the Henry G. Thompson and Sons Co. in the Palace of Manufactures, whose exhibit consists of an interesting line of hack, power, and jig saws for cutting metals, and also some very clever tool holders.

The requirements of modern civilization have opened up many and varied fields for the engineer to cultivate for the good of humanity; this is very forcefully illustrated in the matter of food preservation and today there are large establishments devoted to the production of refrigerating machinery. There are four exhibits of refrigerating machinery at the Exposition that merit attention. Two of these are in the Palace of Food Products, one in the Horticultural Palace, and one in the Manufactures building.

The Larsen Ice Machine Co. has a very fine and interesting exhibit consisting of a complete plant for the freezing, storing, and hardening of ice cream, the daily capacity of the plant shown being 400 gal. The freezer cylinders and agitator are of German silver made without a seam, insuring perfect cleanliness.

Near this exhibit is that of the York Manufacturing Co., which is an exhibit of a complete refrigerating plant in operation, keeping cold several chambers throughout the building.

The exhibit of a complete refrigerating plant by the Vulcan Iron Works will be found very interesting. The refrigerating chambers are a part of the exhibit and, being of glass, show the splendid condition of the foods inside, there being no sign of dampness either on the inside of the glass insulation or on the contained meats, butter, cheese, etc.

The remaining exhibit of refrigerating machinery is by the Automatic Refrigerating Co. and is the only complete automatically controlled refrigerating plant on exhibition. The automatic control is a decided step in advance on new ground; it automatically stops the machine when the temperature in the refrigerator chamber reaches a point one degree below the temperature for which the machine is set and starts it again when the temperature is one degree above that point.

There are many other engineering exhibits in the Palaces of Machinery, Transportation, and Manufactures. Among those worthy of mention are the Dodge Manufacturing Co.'s exhibit of general power transmission machinery and accessories, which includes a good example of the Dodge system of rope drives. There is also the Zimer vibrating screen, an ingenious combination of reciprocating and tossing action by which the material is screened and conveyed at the same time, designed especially for moving and segregating hot ores, bolts, rivets, ashes, slag, etc.

The exhibit of lubricating oils made by the Union Oil Co. of California shows real achievement in petroleum technology and the company deserves great credit for its scientific development of lubricants from California crude oils. As petroleum specialists, this company has succeeded in developing oils suitable for all classes of lubrication, as has also the Standard Oil Co., which has shown great skill in the treatment of oils for the many and varied uses to which its product is applied.

To the engineer interested in the distribution systems of water works, the exhibit of the A. P. Smith Manufacturing Co. is one of great interest; this is a collection of water gate valves, fire hydrants, water works machines and appliances. The most interesting feature is the exhibit of appliances used for placing a gate valve into a line of main pipe while the latter is under pressure.

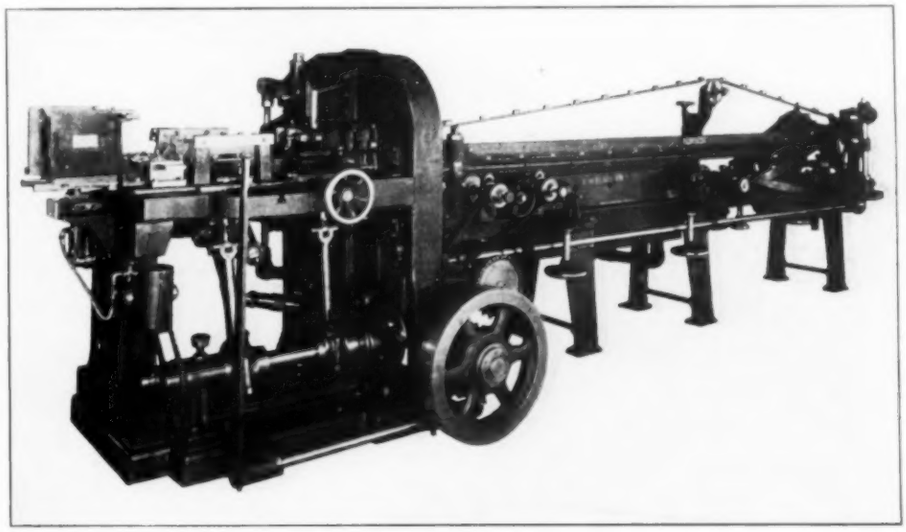


FIG. 8 E. W. BLISS CO.'S AUTOMATIC CAN BODY MAKER. CAPACITY 150 CANS PER MINUTE

The economical handling of materials in the shop is illustrated in the working exhibit of the Shephard Electric Crane and Hoist Co. This consists of electric power cranes and hoists for use from one or two overhead supports; also an electric winch, monorail track, and electric controllers and switches especially adapted for hoisting apparatus.

The General Electric Co. shows a complete self-propelled electric truck on which is mounted an electric crane; this is demonstrated in operation and is an attractive and instructive exhibit.

The correct measurement of the quantities of liquids during their transmission through pipes has always been an interesting problem, and at the Exposition are two exhibits, that of the Neptune Meter Co. and that of the National Meter Co., illustrating apparatus for this purpose.

The Neptune Meter Co. shows a very complete and well arranged collection of various types of meters designed to measure and record different liquids in various units and quantities.

A special form of the compound meter known as the "Protectus" is shown; this is of new design and contains in combination a disc meter, a turbine meter, and a "Control Orifice Tube" with an automatic check valve at the delivery end of the tube. This valve is operated by excess pressure in the tube when the flow from the discharge pipe of the compound meter exceeds 50 per cent of the capacity of the disc meter. The opening of the check valve acts mechanically to close the outlet valve of the disc meter and stop its action and open wide the passage through the orifice tube and the turbine meter. The turbine meter is proportioned to measure 25 per cent of the flow through the orifice tube and to register the combined flow of itself and the orifice tube. A special adaptation of the disc meter is shown in an apparatus for measuring and recording a predetermined quantity of liquid and automatically stopping the meter and the flow when that quantity has passed the meter.

Among others a meter of the turbine type named "Gem"

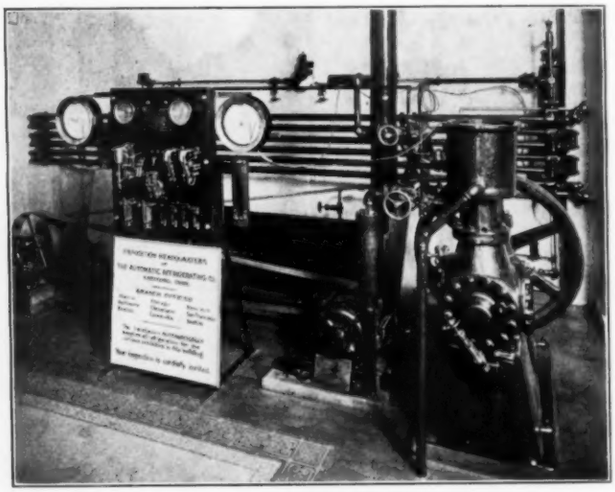


FIG. 9 REFRIGERATING PLANT EXHIBITED BY THE AUTOMATIC REFRIGERATING CO.

is shown; this is adapted only to the measurement of large and rapid flows and is used either alone or in combination with one of the oscillating piston type called "Empire," to form the "Empire Compound." In this arrangement the passage through the "Empire" is always open while that through the "Gem" is controlled by an automatic differential check valve which opens under the difference of pressure produced by a large flow through the "Empire" meter. Of special interest is an apparatus having the name of "Premier" to be placed in 30-in. water mains. It consists of one large and one small venturi tube in parallel relation.

Both these exhibits of meters are of great interest to the engineering profession, which is sufficient excuse for giving a somewhat lengthy description of them.

At the Exposition there is a large amount of pumping machinery for all the varied purposes for which pumps are used. The Luitwieler Pumping Engine Co. has an exhibit consisting of Luitwieler pumps of two different types adapted to surface, deep well and hydraulic service. The special feature is the method of driving. In place of the usual crank shaft operating through connecting rods there are eccentric or heart-shaped cams with the face of the cam working on rollers to produce the motion for the pump ram or bracket. The motion transmitted to two or more pump rods may be so arranged as to give a non-pulsating constant discharge of water or other liquid. The surfaces of the cams are hardened as well as the rollers; they are both generous in size and little wear need take place.

The Layne and Bowler Corporation exhibits a turbine pump especially adapted to deep wells. Its special feature lies in the pump chamber being suspended from its upper end, as are the rotating parts. The shaft rotates inside a central pipe in which it has bearings at intervals, lubricated with oil or clear water injected at the top of the pipe; the shaft bearings are thus protected from contact with dirty water. The rotating parts are carried on roller bearings at the upper end of the shaft, and for heavy pressures these are supplemented by oil pressure applied between one or more pairs of discs.

The Krogh Manufacturing Company exhibits a variety of centrifugal, turbine, and plunger pumps for various uses, which are of good design. Among these are a vertical centrifugal mine sinking pump, cornish pumps, jack head pumps, multi-stage mine station pumps, single-stage motor driven horizontal centrifugal pumps, multi-stage high pressure turbine pumps, and a long double-suction centrifugal pump with a capacity of 30,000 gal. per minute. Each rotating disc fixed to the shaft is enclosed within a close fitting bronze ring which has free lateral movement. This is a well-designed pump marking progress in a class of machinery that has been in a stationary condition for some time past.

The American Well Works has an exhibit consisting of a large variety of centrifugal, turbine, and deep well plunger pumps, of good design.

Closely connected with pumps are pipes, valves, and fittings. These are found in great variety and of all dimensions in the Crane Co.'s exhibit, some of the main features of which are: One 72-in. wedge water gate in operation worked by a hydraulic lift and weighing 56,000 lb.; one 36-in. wedge water gate in operation worked by a motor; a complete line of steel water gates from 2 in. to 18 in.

There are many other exhibits that should have been mentioned if space permitted. In the Palace of Mines there is much that is interesting and new. This branch of engineering coupled with the advance in chemistry and metallurgy has made great progress in recent years and much of that progress can be traced in the exhibits in this building.

In the Palace of Transportation, the progress in that field of engineering can be traced through all its stages. In one corner is found an interesting old pioneer with the wagon in which he crossed the continent 65 years ago and from that point of beginning can be followed the progress in transportation upon to the present day, when 60 miles an hour can be made on our improved highways with almost the comfort of a railroad coach.

From the great exhibit of the Westinghouse Co. in the Palace of Transportation as a center, wherever one turns new wonders of mechanical genius continually arrest attention, and the skill that has conquered the land, the sea, and the air, all help to raise the engineer's estimate of the worth and dignity of the profession to which he belongs.

FOREIGN REVIEW AND REVIEW OF PROCEEDINGS OF ENGINEERING SOCIETIES

ENGINEERING SURVEY

Among the problems of power generation which still await solution is that of the gas turbine. Holzwarth, it is true, built a gas turbine rated at over 1000 h.p. more than three years ago, but it has never been placed on the market commercially and its efficiency as claimed by Professor Stodola appears to be quite low. Of late, papers have stated that a large amount of work has been done on the gas turbine by the Brown-Boveri Company, which is said to have organized a special department for this work which is there carried on with a considerable amount of secrecy. Nothing concerning it has been reported in the regular trade papers, but from the newspaper reports it appears that the Brown-Boveri Company, like many other experimenters with gas turbines, had considerable trouble on account of the rapid wear of the turbine blades. In this month's Survey, an abstract is given of an article by Alfred Walter, on Gas Turbines, in which the author makes several statements of considerable interest. In the first place, he claims that the explosion type of gas turbine is limited in its possible development and that it is the constant pressure type that is likely to give the final solution. Further, he expresses a belief that the gas turbine will finally be developed along lines somewhat similar to those of the steam turbine, viz., that multiple wheels will be adopted for the gas turbine also. As a continuous process of flow does not appear feasible practically in the case of a gas turbine, the writer recommends a process composed of elements occupying long periods of time. He describes a design of gas turbine on rather novel lines, in which there are three chambers, two of which are working continually, while the third is in the state of cooling.

This Month's Articles

The Diesel engine propelled ship, *Pacific*, with its power plant and electrical equipment, is described. The article contains some data showing the growing adoption of the Diesel engines for ocean ship propulsion.

The next article compares the Diesel engine with the suction producer gas engine for ship propulsion, and shows that at certain prices for anthracite and oil, the suction producer gas engine may prove to be more economical than the Diesel engine.

F. Hoffmann presents data on the maximum contents of hydrocarbons in producer gas and among other things, gives a table showing the average output of gas from the most important German types of gas coals.

P. Ludwik describes an investigation into the properties of metals at higher temperatures; for steel and wrought iron up to 1300 deg. cent. This article is of interest, as comparatively little information has been published on the variation of strength of metals in these regions of temperature.

A communication from the Institution for Testing Materials of the Royal Technical High School at Stuttgart, is devoted to the investigation of the brittleness of wrought iron, produced by the heating of compressed materials. It is of particular interest to boiler engineers, as it affects the strength of the notched boiler plates. (The notching may come from knocking off scale.)

The question of the saving of fuel on locomotives by the use of feed water preheating and the differences in effectiveness of various types of preheaters, as well as the field of application for preheaters, is carefully considered in an article abstracted from a German periodical. In the same section are described locomotive superheaters using smoke tubes of small diameter.

Interesting statistical information on the increase in safety of boiler operation in Prussia is reported and illustrated by curves. The article shows that the number of explosions due to various causes is gradually decreasing and moreover, while, for example, the number of accidents due to careless attendance has increased during the last few years, the number of *explosions* due to this cause has decreased, which would indicate that boilers are being so built that they can withstand a certain amount of carelessness in handling without actually going to pieces.

A steamship is described having turbo-electric propulsion, the system at the steam end consisting of a Ljungström turbine, with a total ratio of transmission between turbine and propeller as 1:133.3.

In connection with the utilization of coke as fuel under boilers, the Belani grate is described, with its provision for igniting the coke before it reaches the traveling grate.

Of the papers presented before the American Institute of Mining Engineers are reported those on the manufacture and test of silica brick for the by-product coke oven, on mine pumping and a conveyor belt calculating chart.

From the Journal of the American Society of Naval Engineers are reported papers on the heat losses in steam engineering, methods of testing safety valves at the United States Naval Experiment Station and on land storage of bituminous coal. The latter paper is of particular interest as it raises grave doubts as to the effective ability of the United States Navy coal storage plants to safely store the amounts of coal for which they have been designed.

William Rodger, in a paper before the Canadian Railway Club, discusses the relative advantages of using hydraulic presses as compared with power presses for the manufacture of cartridges and shells.

Data on interesting tests of butterfly valves on locks in the Black Warrior region in Alabama, are abstracted from the Professional Memoirs of the Corps of Engineers, United States Army.

FOREIGN REVIEW

Internal-Combustion Engineering

Diesel Engine Propelled Ship, *Pacific*, W. Kaemmerer.

Description of the Diesel engine propelled ship, *Pacific*, and its power plant.

The Burmeister & Wain Company, of Copenhagen, are the largest builders of Diesel engine ships. They now have under construction ten ships of 10,000 tons each, three of 9000 tons, six of 8000 tons, one of 7000 tons and three of 6500 tons.

The *Pacific* made its trial runs last December and was at once taken over by the owners, who proposed to use it for

the La Plate and Pacific Ocean business. It is 110 m. (360 ft.) long over all, 15.5 m. (50.8 ft.) beam, 7 m. (22.9 ft.) draught and has a capacity of 6500 tons. The engine room is very short and is located in the stern end of the ship. The ship has three decks and five loading hatches, each served by two electrically driven winches.

The power plant consists of two directly reversible 4-stroke cycle Diesel engines having each six cylinders, 540 mm. (21.2 in.) bore and 730 mm. (28.7 in.) stroke, delivering together 2000 i.h.p. Contrary to the practice of Diesel engine building in German shipyards, in this case the engines are enclosed and provided with lubrication under pressure. The arrangement, however, is such that the cylinders are left easily accessible. They are cast in blocks of three and although they are open on the bottom, the piston rods pass through stuffing boxes, the purpose of which is to prevent dirt from the cylinders falling into the lubricating oil. The pistons are comparatively short and are equipped with self-tightening rings. Each cylinder cover has built into it a fuel valve, suction, exhaust, starting and safety valves, the starting valve being water cooled. Each engine has six fuel pumps,—one for each cylinder,—all driven from a common shaft. The pumps take the fuel by suction from two tanks located in the engine room, containing enough fuel for a run of 24 hours. They are filled every twelve hours, which gives the oil a chance to deposit some of the impurities which it contains. The cross-heads of the engines have guides on one side and in all other respects are similar to those on steam engine driven ships.

In addition to the main engines, there are two auxiliary Diesel engines, likewise 4-stroke cycle, each driving a dynamo and compressor, and each delivering 200 i.h.p. at 225 r.p.m. For the usual requirements of the ship one engine is sufficient, the other serving merely as an auxiliary unit. Each compressor delivers air at from 20 to 25 atmospheres. This air is stored in two steel tanks, from which it is taken to start the engines. Each of the main engines has in addition a high pressure compressor which takes the air from the auxiliary compressor at 20 to 25 atmospheres and compresses it to 60 atmospheres. Each of the high pressure compressors is large enough to deliver the entire air blast for the two main engines. All the pumps (two centrifugal pumps for the cooling water, two centrifugal pumps for the oil under pressure, two charging pumps, and two pumps for drinking and service water) are driven separately by electric motors, the centrifugal pumps directly and the other pumps through gear transmissions.

When loading and unloading the ship, the compressors are uncoupled from the auxiliary Diesel engines which then serve to drive the dynamos exclusively. One dynamo is in most cases sufficient to deliver all the current required for the winches and the other auxiliary machinery and lighting purposes. When the winches are not at work and the operation of a large Diesel engine would be economical, the lighting current is supplied by a small 110-volt dynamo, driven by an ordinary 2-stroke cycle crude oil engine. This auxiliary dynamo also delivers current to drive a small high pressure air compressor furnishing compressed air for starting the auxiliary Diesel engines; this compressed air is stored in a separate tank which can be fully charged in two hours.

For heating purposes, there is installed in the rear end of the engine room a vertical boiler with oil firing. The total weight of the engine plant, with its entire equipment, auxiliary engines, pipes and repair parts, is 440 tons. The fuel which has to be carried for a return trip to South America is less than 700 tons, and therefore, as compared with the steamship, it can carry about 1000 tons more cargo. During test runs, the *Pacific*, with an output of 2032.5 i.h.p., has developed a speed of 11.41 knots. (*Das Motorschiff "Pacific," gebaut von Burmeister & Wain A.-G., Maschinen- und Schiffbau-Anstalt in Kopenhagen*, W. Kaemmerer, *Zeits. des Vereines deutscher Ingenieure*, vol. 59, no. 34, p. 677, August 21, 1915, 5 pp., 10 figs., *d*.)

Oil and Suction Producer Gas Engines for Ship Propulsion

The article gives comparative data on the economy of operation of Diesel engines on one hand and producer gas engines on the other, as applied to ship propulsion.

The author believes that the producer gas engine cannot be dismissed as being uneconomical, even though it has not yet been brought up to its full perfection. He cites the following comparative data of operation of the two types of power plants (In the original article the figures are apparently misprinted and an attempt has been made in the abstract to give what would appear to be the correct figures. The doubtful figures of the original article are enclosed in straight brackets side by side with those which would seem to be the correct figures).

It is assumed that a marine Diesel engine consumes about 0.2 liter (0.21 qt.) of oil per h.p.-hr. Under these conditions, 100,000 h.p., at a price of 5 pfennigs per liter, will cost approximately 1000 marks (say $240). A suction gas engine of the same output, consuming 0.454 kg. (say 10 lb.) of anthracite per h.p.-hr. will burn, with anthracite at 24 marks per metric ton, approximately 1100 marks per 100,000 h.p.-hr. In order that such an engine should work as economically as a Diesel engine, the price of anthracite must go down to about 22 marks per ton. In this case, therefore, and in all others where Diesel engines are used having a fuel consumption as low as 0.2 liter per h.p.-hr., the suction engine is economically less efficient than the Diesel engine. If, however, the price of the Diesel engine oil goes up to say 6 pfennigs per liter, or 60 marks (say $14.85) per metric ton (2200 lb.) then the cost of fuel with the Diesel engine rises substantially to about 1250 marks per 100,000 h.p.-hr., while if the suction gas engine uses anthracite at 26 marks per ton, the cost of producing 100,000 h.p.-hr. goes up to only 1180 marks [1080 marks].

The above data just referred to can be considered as average prices for the two fuels and show a slight advantage in favor of the suction gas engines. It must, however, be borne in mind that the price both for oil and for anthracite is often higher. If now the suction engine be compared with a gasoline engine, the advantages in favor of the former will be still more pronounced. A gasoline engine consumes approximately 0.33 liter of fuel per h.p.-hr. and therefore 100,000 h.p.-hr. will cost about 2000 marks as compared with 1180 marks [1080 marks] for the suction gas engine of the same output.

The author states that the oil engine in its various forms is so well intrenched in its position that it is doubtful if in the near future the suction gas engine will find more favor in marine circles than it does to-day, but when this happens, the suction gas engine will be found fully efficient for marine propulsion (*Untersuchungen zwischen Schiffsöl-*

und Sauggasmotoren, Polytechnische Rundschau, supplement to *Elektrotechnische Rundschau,* vol. 32, no. 30/31, August 4, 1915, 2 pp., 3 figs., *ce*).

MAXIMUM CONTENTS OF HYDROCARBONS IN PRODUCER GAS, F. Hoffmann.

The author believes that in many cases the results of analysis of producer gas with respect to the contents of hydrocarbons are subject to doubt, and he thinks that it might be of interest to establish the limits within which the contents of hydrocarbons in producer gas can vary. With respect to producer gas made from bituminous coal, it can be established without particular difficulty.

It appears that this question has never yet been fully investigated. The author discusses first the generation of producer gas, and divides its constituents into the following four classes:

1. Steam.
2. Products of dry distillation, consisting mainly of tars, hydrocarbons and hydrogen, with a small addition of carbon monoxide and carbon dioxide.
3. Products of gasification, mainly carbon monoxide with carbon dioxide and hydrogen from steam supplied into the producer.
4. Nitrogen which comes mainly from the air supplied for the purposes of gasification and only to a very slight extent from nitrogen in the coal (under certain conditions, such as leaks in the piping, some air may be found in the producer gas, shown during the analysis by the presence of oxygen in amounts larger than traces).

A good basis for the determination of the highest contents of the products of distillation in bituminous coal gas producers is given by the data obtained in the manufacture of illuminating gas. It must, however, be remembered that computation based on average figures never strictly coincides with data actually obtained, especially as the conditions of dry distillation present in the manufacture of illuminating gas are not unessentially different from those in the manufacture of producer gas. With our present insufficient knowledge of the processes occurring in dry distillation of coal, we must be very careful how data of experience with pure dry distillation is transferred to dry distillation in the gas producer, particularly in view of the fact that the dry distillation in the producer occurs at a lower temperature (especially when much steam is added) than in illuminating gas retorts.

As a basis for calculation of the amounts of products of dry distillation, the author uses, chiefly, data of experiments obtained in the laboratory at Karlsruhe on test distillation of fifty of the most important kinds of German gas coals (published in *Journal für Gasbeleuchtung,* 1913-1914).

In analyzing the figures of the output, the contents in illuminating gas of nitrogen and various compounds of nitrogen and sulphur have been neglected in order to simplify the computations. This is permissible with respect to nitrogen because the nitrogen in the gas is due mainly to the unavoidable presence of air in the gasification chamber. On the other hand, K. Bunte has shown that of the nitrogen present in the coal, approximately 60 per cent passed into coke 20 per cent, as free gas, into the illuminating gas; 15 per cent into ammonia; 3 per cent into cyanogen and 2 per cent into tar, so that it may be assumed that when coal is gasified in a producer, practically 80 per cent of the nitrogen present in the coal will be found as gas in the producer gas. This is the figure which the author uses in his computation.

Table 1 gives the average output of gas of the most important German types of gas coals [referred to pure coal and the elementary composition of the gaseous products of dry distillation obtained from 100 kg. (220 lb.) of pure coal]. This table shows that the gases of distillation as obtained from 100 kg. of pure coal are essentially as follows:

9.346 kg. Carbon + 3.685 kg. Hydrogen + 3.423 kg. Oxygen.

The author then proceeds to discuss the output and composition of the tar formed in dry distillation and comes to the conclusion that if nitrogen and sulphur be neglected the following formula would hold good: in 100 kg. of tar there are 92.5 kg. Carbon + 4.4 kg. Hydrogen + 2.2 kg. Oxygen. (*Die Maximalgehalte des Generatorgases an Kohlenwasserstoffen,* Fritz Hoffmann, *Feuerungstechnik,* vol. 3, no. 22, p. 269, August 15, 1915, article not finished, and abstract will be continued in an early issue.)

TABLE 1A AVERAGE GAS OUTPUT FROM THE PRINCIPAL GERMAN GAS COALS (REFERRED TO PURE COAL)

Average of Tests:	Total output of gas	C_nH_m	CH_4	CO_2	CO	H_2
	(in cbm.: 1 cbm. = 35.314 cu. ft.)					
16 samples of Saar coal	36.6	1.21	10.51	0.82	3.41	18.9
14 samples of Ruhr coal	34.2	1.08	9.70	0.54	2.78	18.6
10 samples of upper Silesia coal	34.2	1.11	9.34	1.03	3.98	17.2
11 samples of other German coals	34.7	1.03	10.33	0.70	3.10	17.8
Average of the above 50 samples	35.0	1.11	10.09	0.76	3.28	18.2

TABLE 1B COMPOSITION OF GASES OF DISTILLATION (FROM 100 KG., OR 220 LB. OF PURE COAL)

	Absolute output of gas in cbm.	Relative weight of 1 cbm. in grams			Absolute weight of output of gas in grams		
		C	H	O	C	H	O
C_nH_m	1.11	1610	210	..	1787	231	..
CH_4	10.09	535	180	..	5398	1816	..
CO_2	0.76	535	..	1428	405	..	1081
CO	3.28	535	..	714	1756	..	2342
H	18.2	..	90	..	..	1638	..
Total	33.4	..	..	..	9346	3685	3423

GAS TURBINE, Alfred Walter.

Discussion of the question of the gas turbine.

The author believes that the entire problem is handled in a wrong manner and especially that insufficient attention is paid in the attempts to design a gas turbine to the designs of steam turbine engineering. He objects, for example, to the rather general assumption that in a gas turbine only an impulse wheel should be used and that the waste heat of the exhaust gases should be utilized in a regenerator.

While he believes that in general the tendency in the development of the gas turbine is towards the ideal Carnot

cycle, he points out that the reciprocating steam engine as a periodical machine and the turbine as a continuously acting machine, go along entirely different roads toward the common goal,—the Carnot idea.

With particular reference to the gas turbine, the author believes that a great obstacle to its development lies in the assumption of the theoretical superiority of the explosion type of turbine over the constant pressure turbine. One cannot help objecting to placing a blade wheel in front of a periodical mechanism (explosion chamber with many valves), even though theory says that that is the right way to do. The author asks why one could not get some sort of an arrangement which would allow a continuous or at least a long period flow of gases of combustion to the turbine wheel. As regards the explosion turbine, he believes that there is a limit to its possible development. Its first successes were due to the fact that it represented the most primitive combination of an explosion motor and a turbine. Actually, however, in order to secure continuity of work, chamber on chamber have to be added with numberless valves and rods, and if so, what becomes of the simple gas turbine sought for?

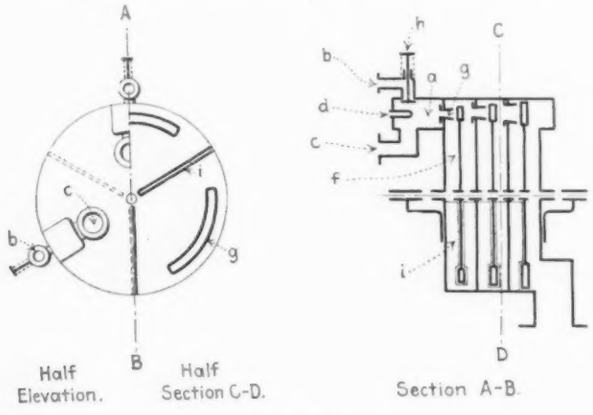
The author attaches particular importance to a clear understanding of the following four points:

a. Since a pure continuous constant pressure process is practically impossible, processes should be selected which permit the greatest amount of continuity, such, as for example, the constant pressure process having long periods in which the period of combustion per chamber must be drawn out as long as possible with the temperatures obtaining under possible cooling.

b. A powerful cooler should be installed both for the combustion chambers and the entire turbine, without, however, excessive consumption of fuel and loss of heat.

c. An attempt should be made to use a simple impulse wheel or normal turbine device (multiple wheel and drum, impulse and reaction), which afford the best results with respect to efficiencies, mechanical strength and wear.

d. The question should be considered as to how the exhaust heat may be utilized in other ways than by means of a regenerator.



WALTER GAS TURBINE FIG. 1

In addition to the above, the author describes a novel process of his own, in which the usual constant pressure method is used, but the working cycle occurs, though intermittently, still at long periods. The air is admitted to the combustion chamber continuously under constant pressure and the air of combustion and the cooling air are admitted by the same pipe. The fact that the pressure in the combustion chamber is approximately constant makes it possible to use the normal type of turbine, in addition to which provision is made for a strong cooling of the entire turbine.

The large amount of air which has to be used in connection with this process appears to be a disadvantage at first, but the author claims to be able to show that this is what makes the process possible at efficiencies which are not excessively unfavorable. Fig. 1 shows the diagrammatic construction of the turbine. There are assumed to be three combustion chambers, *a*, of which two are working and one is in the state of being cooled. Through the pipe *b* the fuel is admitted into the combustion chamber and through pipe *c*, the air. In the combustion chamber is found further the ignition device *d* (hot bulb or electric). In all the three chambers the same pressure prevails. All the three chambers are freely connected with the turbine space *f*, by expansion nozzles *g*. Into the chamber which is being cooled at the time there flows from the compressor, air through pipe *cd;* this air takes up the residues of combustion and expands in the nozzle *g*, delivering some work to the turbine so that a certain part of the energy consumed by the compressor is again recovered in the turbine.

The expansion produces a powerful cooling of the air in addition to which the air constantly takes hot water from the walls of the turbine wheels, which constitutes a further addition to the work done by the air. In this light, the minus in heat loss of gases of combustion through cooling really appears as a plus. After the completion of the cooling period, the automatically operated fuel valve *h* opens and the fuel is blown into the combustion chamber through pipe *b*, mixes there with air and is ignited.

A proper shape of combustion chamber adapted to the kind of fuel used will produce either rapid or slow combustion. The mixture is expanded through the nozzle *g* and does its work in the turbine. Owing to the fact that in the chamber *a*, there prevails an approximately constant pressure, it is possible to build the turbine with more than one wheel and to obtain in this way conditions of work and efficiencies approximating those used in steam turbine construction. This has the further advantage that the cooling of the entire turbine is made possible, which depends on the conditions of flow in the turbine.

The author claims for this construction the advantage of having a small number of parts the motion of which has to be controlled, high thermodynamic and mechanical efficiency, low gas velocities and speeds and efficient utilization of the cooling air.

(*Gedanken und Anregungen zur Frage der Gasturbine*, Alfred Walter, *Zeits. für das gesamte Turbinenwesen*, vol. 12, no. 23, p. 265, August 20, 1915, article not finished, *td.*)

Materials of Construction

PROPERTIES OF METALS AT HIGHER TEMPERATURES, P. Ludwik

The article is devoted to an investigation of the properties of metals at higher temperatures. The following metals have been investigated: aluminum, lead, cadmium, wrought iron, cast steel, copper, magnesium, brass, nickel, zinc and tin.

All the metals were taken in wire form, commercial brands

of the highest purity obtainable. The length of the test bars was approximately 60 cm. (23.6 in.). The bars were heated in an electric furnace, the temperature being measured by various thermo-elements. In all tensile tests, the following values were determined:

The original cross-section of bar $f_o = \frac{\pi d_o^2}{4}$

The test temperature

The highest load obtained P

The cross-section of bar f

The cross-section at the place of rupture f_b.

Then

$K_z = \frac{P}{f_o}$ is *tensile strength*

$\sigma = \frac{P}{f}$ is *tensile stress*

$100\frac{f_o - f_b}{f_o}$ contraction, in per cent

$100\frac{f_o - f}{f_o}$ uniform elongation, in per cent.

Contraction and corresponding elongation give at the same time the limiting values of elongation on rupture of pieces of various lengths.

As regards the various metals investigated, the following remarks are of interest:

Aluminum. With increasing temperature, the hardness and strength steadily decrease, while the ductility and malleability steadily increase. At 500 to 600 deg. cent., the latter was so great that aluminum, like lead, could be drawn to a fine point.

Wrought Iron. While the iron tested was not chemically pure, it was of very low carbon content (the chemical analysis indicated 0.06 per cent carbon, 0.47 manganese, 0.037 phosphorus and traces of silicon). The curves in Figs. 2A and B make clearly apparent the well-known fact that at the so-called blue heat (about 250 to 300 deg.) there is a higher strength with greater brittleness. At 600 deg. the ductility is at its maximum. Of interest also is the rise of tensile strength at about 800 deg.

Cast Steel. Virtually it was hard wrought iron close to the steel limit. As in the case of wrought iron, the maximum of strength and brittleness was reached at about 250 deg. At about 600 deg., likewise, the ductility is at its maximum.

Copper. A decrease of strength with increase of temperature is continuous down close to the melting point. The contraction of area materially decreases between 200 and 600 deg., increases at about 800 deg. and starts to decrease again above it.

Brass. Strength and ductility decrease as a rule with increase of temperature.

As regards the metals in general, the variation of strength with temperature falls into two main classes. The pure metals, with the exception of iron and nickel, show a fairly constant decrease of strength with temperature, while iron and nickel, as well as most of the alloys, show pronounced variations within certain characteristic regions of temperature which the author ascribes to allotropic transformations occurring at those temperatures.

The author discusses in considerable detail the question of variation of specific heat of metals with temperature and brings out data on the relation between the heats of melting and volume moduli. An interesting part of the article is that devoted to the consideration of the relation between the atomic volumes of metals on the one hand and their hardness and strength on the other. (*Festigkeitseigenschaften und Molekularhomologie der Metalle bei höheren Temperaturen*, P. Ludwik, *Zeit. des Vereines deutscher Ingenieure*, vol. 59, no. 33, p. 657, August 14, 1915, 8 pp., 9 figs., *et.*A.)

Brittleness of Wrought Iron as a Consequence of Heating Compressed Material, R. Baumann

The article is a communication from the Institution for Testing Materials of the Royal Technical High School at Stuttgart.

The tests carried out have been prompted by the observation that boiler plate, which has been deeply notched during the process of knocking off boiler scale, proved to be very brittle, which may have been due to the action of compression

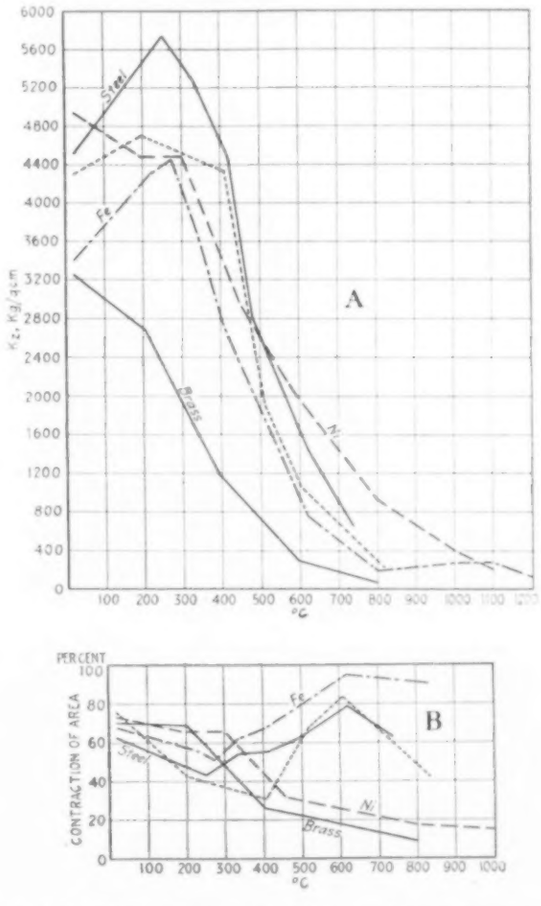


Fig. 2 A: K_z, "Tensile Strength" of Metals at Various Temperatures; B: Contraction of Area of Metals at Various Temperatures

together with subsequent heating to a sufficiently high temperature. Tests have also shown that other kinds of boiler material developed after cooling a considerable amount of brittleness if previously compressed and then heated to a yellow color. This may afford an explanation for many cases of rupture of boiler plates and the formation of cracks, as com-

pression and subsequent heating are phenomena of frequent occurrence.

As a rule the presence of deep notches or compression alone are not enough to produce material brittleness. To bring this about, it is necessary that a corresponding amount of heat be applied, and that, further, the constitution of the material be of a certain definite nature. Often test bars made from the same plate do not become brittle to the same extent. The old rule, that unnecessary notches should be avoided, etc., has not been discredited by the present tests.

The author describes a process which has been applied for testing boiler plate and established the inferior quality of some plates, which had passed the usual tests satisfactorily, but developed cracks in actual service. This test consists in pressing a cylinder of hardened steel 10 mm. (0.39 in.) in diameter against the face of the plate normally to the skin due to rolling and at an angle of 60 deg. to the axis of the bar; loading with a pressure of 2500 to 3000 kg. per cm. of length of bar subjected to pressure (13,750 to 16,500 lb. per in.), the thickness of the test bar being 15 mm., and then heating the bar to a yellow color and bending it after cooling in water.

The tests were carried out on plates 20 mm. thick (0.78 in.) having a tensile strength of 4100 kg/qcm. (say 58,000 lb. per sq. in.). The behavior of plates of greater thickness and higher tensile strength has not been established by the present tests.

The tests have clearly established the influence of direction of rolling, a fact which has to be taken into consideration in performing notch shock tests. (*Sprödigkeit von Flusseisen als eine Folge der Erwärmung gequetschten Materials*, Richard Baumann, *Zeits. des Vereines deutscher Ingenieure*, vol. 59, no. 31, p. 628, July 31, 1915, 4 pp., 12 figs. *ed.*)

Railway Engineering

SAVING OF FUEL ON LOCOMOTIVES BY THE USE OF FEEDWATER PREHEATING, Strahl.

Careful consideration of data on the saving in coal and increase of output of locomotives by means of preheating the feed water (compare Table 2), indicates that the use of exhaust steam preheaters gave a saving of 13 to 19 per cent (in accordance with the type of construction and load on the boiler), as compared with similar locomotives without preheaters. But when a waste gas preheater was installed in addition to an exhaust steam preheater, the saving rose to 19 to 27 per cent, or from 6 to 8 per cent more, which is quite a material increase in economy. Actually during test runs on the Prussian State railways, of wet steam and superheated steam locomotives on which exhaust steam superheaters were subsequently installed, the saving of coal within the above limits was established beyond dispute; often it rose to over 20 per cent.

TABLE 2 DATA OF TESTS ON THE EFFECTIVENESS OF PREHEATING ON LOCOMOTIVES AS A MEANS OF SAVING FUEL

Specific Load on Grate of Locomotive $\left(\frac{Bb}{10^3}\right)$ without Preheater		Locomotives with							
		Exhaust Steam Preheating				Exhaust Steam and Waste Gas Preheating			
		Wet Steam		Superheated Steam		Wet Steam		Superheated Steam	
		$t'_r = 360°$	$t'_r = 320°$	$t'_r = 360°$	$t'_r = 320°$	$t'_r = 360°$	$t'_r = 320°$	$t'_r = 360°$	$t'_r = 320°$
2	Temperature of preheated feedwater, deg. cent.	90	90	90	90	130	122	134	126
4		100	100	100	100	144	136	150	141
2	Heat required for the production of 1 kg. of steam, in calories	570	570	634	634	530	538	590	598
4		550	550	635	635	506	514	585	595
2	Heat required for the production of 1 kg. of steam from feed water at 10 deg. cent.	650	650	714	714	650	650	714	714
4		640	640	725	725	640	640	725	725
2	Efficiency of boiler without preheater	0.698	0.718	0.698	0.718	0.698	0.718	0.698	0.718
4		0.576	0.596	0.576	0.596	0.576	0.596	0.576	0.596
2	Efficiency of boiler with preheater *at the same* output	0.713	0.733	0.711	0.732	0.721	0.739	0.719	0.738
4		0.610	0.630	0.607	0.627	0.627	0.644	0.623	0.640
2	Saving in coal *at the same* output due to preheater	14	14	13	13	21	20	20	19
4		19	19	17	17	27	26	25	24
2	Temperature of waste gases, in deg. cent.	322	284	322	284	230	209	230	209
4		392	348	392	348	292	266	293	267

t'_r = temperature in the smoke-box.

While the saving in coal on locomotives with exhaust steam preheaters in average operations was actually found to be considerably below these figures, hardly exceeding 10 to 11 per cent, this was due to the fact that either the increased capacity of the locomotive could not be utilized beyond a certain limit, or during runs with closed throttle or during periods of standing at stations, the preheating was not available, which affected the results even though feeding the boiler during such periods was avoided as carefully as possible. In this respect, the situation with the waste gas preheater is much more favorable, since the waste gases may be used for preheating the feed water even when the throttle is closed.

The average saving of fuel through preheating by exhaust

steam is the greater the less frequently the throttle has to be closed during the operation of the locomotive. Hence, the economical advantages of feed water preheating on locomotives operating express trains and fast freight trains which make long runs without stopping, is of greater importance than in local passenger trains and ordinary freight train service, and is greater in regular service than on switching locomotives. It is quite possible, and sometimes happens, that the economical advantages of exhaust steam preheating may become entirely insignificant, especially on locomotives which even without preheaters have a sufficient output and the ratios of dimensions are the same as on the superheated steam locomotives of the Prussian State Railways, or 20 to 25 per cent with a smaller ratio of heating surface to grate surface. In good accord with this is the information given by Trevithick, managing director of the Egyptian State Railroads, concerning runs of their superheated steam locomotive, No. 712. The feed water was preheated by an exhaust steam and a waste gas preheater connected in series, to a temperature of 145 deg. cent. With this locomotive a saving of 20 per cent, as compared with two superheated steam locomotives without preheaters, was secured, and with another

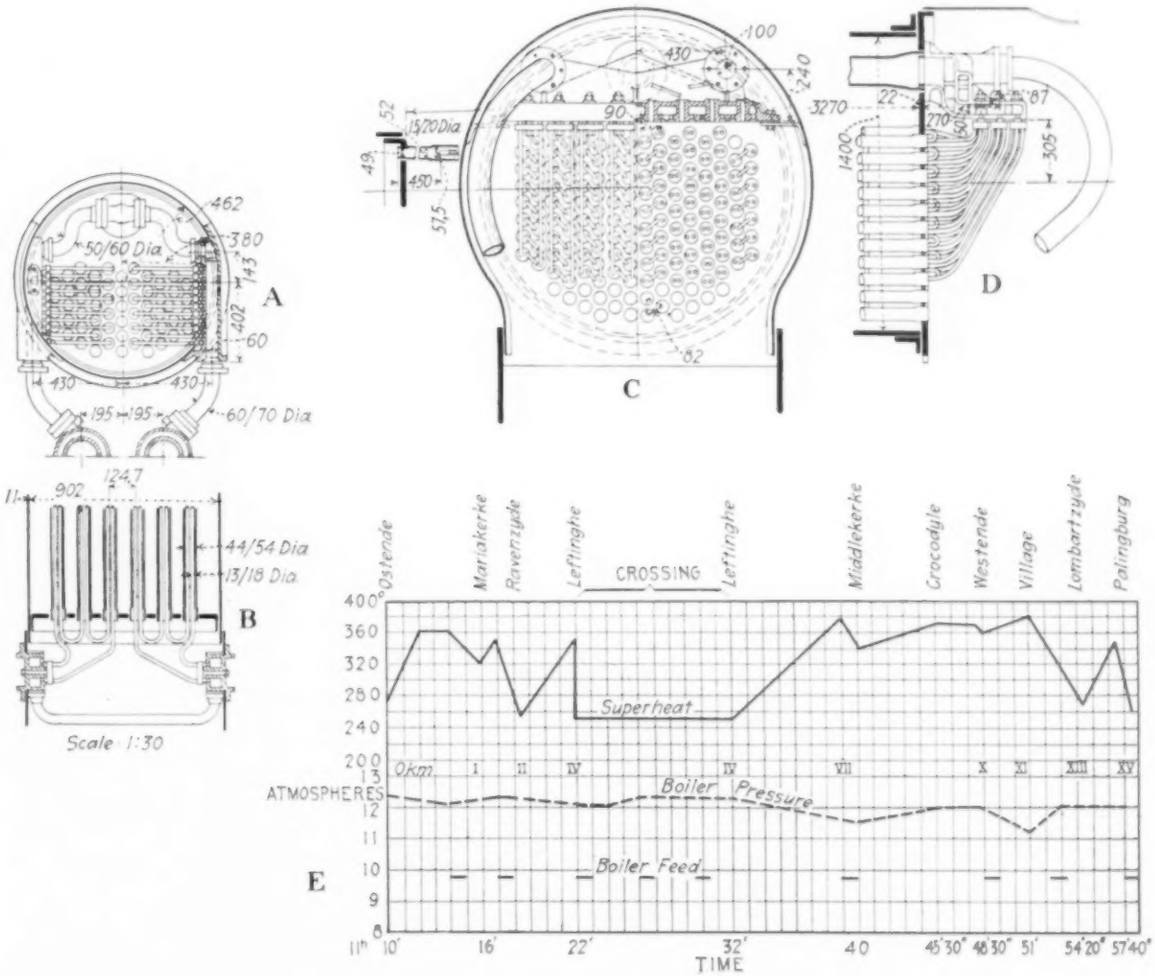


Fig. 3 Locomotive Superheaters with Tubes of Small Diameter

leave but little to be desired with respect to steam generation. It is advisable to install preheaters on locomotives which need them; e.g., when the boilers are already overloaded.

In order to best utilize the increased output of the boiler, it is advisable on new locomotives on which the feed water preheater is installed, to increase the size of the steam cylinders, since otherwise increases of load are possible only to a limited extent. If, however, the size of the cylinders is adapted to the increased output of the boilers, excellent results can be obtained.

The saving of coal by feed water preheating on superheated steam locomotives with exhaust steam and waste gas preheating, amounts to approximately 19 to 24 per cent if similar locomotive, No. 711, a saving of even 27 per cent was obtained, as compared with 29 other locomotives. The latter saving is considered by Trevithick to be too high, because Locomotive No. 711 was placed on test runs when new and was therefore in first-class condition. (*Die Kohlenersparniss oder grössere Leistungsfähigkeit der Lokomotiven durch Vorwärmung des Speisewassers,* Strahl, ***Annalen für Gewerbe und Bauwesen,*** vol. 77, no. 2/914 and 3/915, July 15 and August 1, 1915, *pe.*)

Small-Smoke-Tube Superheaters for Locomotives, Metzeltin.

Description of recent developments in the design of Schmidt superheaters, in particular for locomotives.

The modern type differs from the older type in that the large smoke tubes have been eliminated and the entire boiler filled with tubes of diameter only slightly larger than that of fire tubes hitherto used. The space saved in this manner has been largely, if not exclusively, occupied by superheater elements. This type of superheater construction has several advantages which have been established in practice, as follows:

They give a more rapid and higher superheating than the old smoke tube superheater, and therefore are particularly convenient for street railway service and local lines where many stops have to be made. With the same boiler diameter, the new type of superheater, which is called the "small-smoke-tube" superheater, can utilize about 30 per cent more heating space than the old superheater with large fire tubes could do.

The use of smoke tubes of moderate diameter has above all the great advantages that the walls of the tubes are not exposed to the high stresses which may occur with large smoke tubes. Smooth tubes, 50 to 70 mm. (1.96 to 2.75 in.) in diameter in long boilers, are apt to sag somewhat during the runs of the locomotive, due to their own weight and vibration, so that they cannot offer any great resistance to increase of length on account of the heating. On the other hand, larger tubes of 125 to 133 mm. (4.9 to 5.2 in.) in diameter, often with lengths of 5 to 6 m. (16.4 to 19.69 ft.), do not bend at all and therefore do not yield in any way with rises of temperature. The manipulation of the small-smoke-tubes is no more difficult in locomotive shops than that of larger tubes. The Netherland Tramway Company, in Herenveen, have had 30 tender locomotives with fire tubes 50 mm. (1.9 in.) and superheater tubes 11 mm. (0.42 in.) in diameter, in use for three years without experiencing any serious trouble.

The superheater elements of the small tube superheaters consist usually of 4 or 6 tube bunches, which in their turn consist of two or three tubes. The first arrangement of the steam collector chamber used was such that the chamber was located vertically, parallel to the exhaust blast tube in such a manner that the superheated steam space was in front and the wet steam space behind. This arrangement has the advantage as it is very simple. An arrangement which is considered to be very good is shown in Figs. 3A and B, representing the superheater for a street railway locomotive of the Mass-Buurt railway in Holland. There, each of the steam collector chambers, located to the right and to the left, is divided in two parts for the superheated steam and wet steam. This arrangement permits a very good design of the superheater elements, the two superheated steam collectors being inter-connected by a pipe 40 to 50 mm. (1.5 to 1.9 in.) in diameter. The arrangement shown in Figs. C and D is widely used on the Belgian, Hungarian and Italian railways.

As to the results gained with small-smoke-tube superheaters, an idea may be obtained from the chart in Fig. E, representing curves established by a test of a C-type street railway locomotive on the Belgian local railways. Special attention is called here to the fact that temperatures of 340 to 380 deg. could have been maintained for a comparatively long time. (*Kleinrauchröhren-Ueberhitzer für Lokomotiven*, Metzeltin, *Zeits. des Vereines deutscher Ingenieure*, vol. 59, no. 32, p. 645, August 7, 1915, 6 pp., 21 figs. *d.*)

Steam Engineering

CONCERNING THE INCREASE IN SAFETY OF BOILER OPERATION IN PRUSSIA, B. Hilliger.

The author attempts to prove that the number of boiler accidents in Prussia has decreased during the last few years. He divides all accidents into three groups,—explosions,

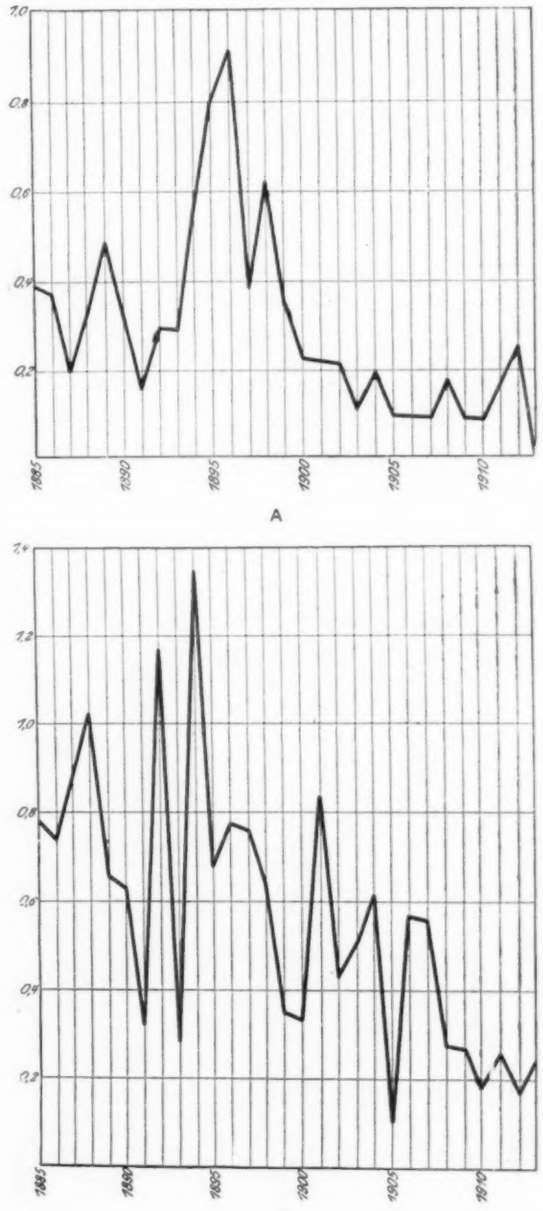


FIG. 4 EXPLOSIONS (PER UNIT OF 10,000 BOILERS) CAUSED BY (A) DEFECTS IN MATERIAL AND WORKMANSHIP, AND (B) DEFECTIVE ATTENDANCE

accidents which lead to the boiler being put out of operation and various defects producing accidents. In the main, disturbances in operation are produced by one of the following four causes: *first*, defects in material and workmanship; *second*, piping, connections and auxiliary apparatus; *third*, attendance, and *fourth*, operating conditions. He reports his data in the form of tables and curves, some of which are here reproduced. Fig. 4A shows the number of boiler ex-

plosions caused by imperfections in material and workmanship, referred, for purposes of comparison in various years, to a unit of 10,000 boilers. The great jump in the number of boiler explosions between 1894 and 1897 is due to the fact that during that time a different definition of boiler explosion was used by the statistical office.

Under the class of explosions due to boiler piping, connections and auxiliary apparatus, are handled all accidents due to jammed or overloaded safety valves, clogged or incorrect manometers or finally, defective feed water apparatus; also accidents due to the clogging of passages leading to the water gages and incorrect indication of water level by the gages. The curve shown indicates that the number of accidents reported as due to this cause is comparatively small and varies widely in different years, which, under these conditions, may be due to accidental causes.

The number of accidents due to lack of proper attendance appears to be comparatively large. Explosions in these cases are very often due to lack of water in the boiler, which can be traced to the carelessness of the fireman. Fig. B indicates the gradual falling off in the number of explosions. (The reasons for an unusual increase of explosions as shown by the curve for the periods 1894 to 1897 has been explained above.) In this connection, the author points out a curious phenomenon,—namely, that statistics indicate that the number of accidents due to careless attendance on boilers has increased in the last few years, while the number of *explosions* due to this cause, has decreased. Since the majority of accidents due to this cause are produced by low water level, it would appear that the boilers are being so built that they can better withstand trouble of this nature. Table 7 offers an opportunity of judging the tendencies in explosions and accidents in boiler plants by giving a comparison between what took place from 1885 and 1889 on one hand, and from 1909 to 1913 on the other. The same data are represented by curves in the original article. (*Untersuchungen über die Zunahme der Sicherheit der Dampfkesselbetriebe in Preussen*, B. Hilliger, *Zeits. des Vereines deutscher Ingenieure*, vol. 59, no. 34, p. 681, August 21, 1915, 7 pp., 10 figs., s.)

TABLE 3. COMPARATIVE DATA SHOWING THE VARIATION IN THE NUMBER OF BOILER ACCIDENTS IN THE LAST 18 YEARS

Causes	Explosions to each 10,000 boilers in the period:		Accidents to each 10,000 boilers in the period:	
	1885–9	1909–13	1885–9	1909–13
Defects in material and workmanship	0.352	0.120	4.48	1.78
Defects in piping connections and auxiliary apparatus	0.246	0.069	2.04	1.84
Defective attendance	0.815	0.225	5.83	6.82
Defective operation	0.351	0.135	5.26	3.90

SWEDISH SHIP WITH TURBO-ELECTRIC PROPULSION

The Swedish coaster, Mjölnir, was built by the Lindholmens Verksted, in Gotenburg, and has a displacement of 2250 tons, a speed of 11 knots, is 68.6 m (225 ft.) long, with 10.97 m (36 ft.) beam and 4.5 m (14.7 ft.) draught. The propeller shaft, which carries a single screw, is driven by two synchronous motors, arranged to transmit their power through a gear transmission with two pinions, each motor operating on one pinion. This transmission reduces the speed from 900 r.p.m. on the motor shaft to 90 r.p.m. on the propeller shaft, the total power delivered to the propeller shaft at 90 r.p.m. being about 900 h.p. The current is generated by two 500 volt, 100 cycle alternating current dynamos, having an output of about 400 kw. each, at 6000 r.p.m. These data indicate that the ratio of transmission between turbine and propeller is extremely high; in fact it is 1:133.3, and this permits the obtaining of a comparatively low steam consumption, notwithstanding the moderate size of the power unit. Although no complete data of any test of the engine have been published, it is expected that the steam consumption will be about 4.5 kg. (9.9 lb.) per shaft h.p.-hr. In runs made previous to delivery simultaneously with the sister ship, Meiner, driven by triple expansion steam engines, it was found that the new ship had a coal consumption 35 per cent less than the other steamer. (*Ein neuer turbo-elektrischer Schiffsantrieb*, F., *Zeits. für das gesamte Turbinenwesen*, vol. 12, no. 23, p. 274, August 20, 1915, 1 p. *d.*)

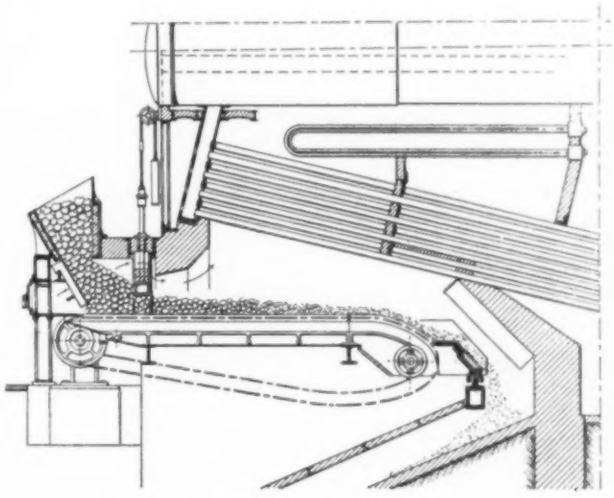


FIG. 5 BELANI GRATE FOR BURNING COKE UNDER BOILERS

COKE AS FUEL UNDER BOILERS, H. Markgraf

In a previous issue of *The Journal* (September, 1915, p. 558) reference has been made to efforts in Germany to supplement the lack of the usual coal fuel by the utilization of coke, and to various experiences in this connection. The present article covers approximately the same ground in a more detailed way, and brings up some comparatively new data.

First, the author points out that, contrary to the prevailing impression, the temperature of combustion coke is lower rather than higher than that of coal. He shows that in order to attain the same temperature in the furnace, the combustion of coke must be much more complete than that of coal. Judging temperature by the color of the flame with the naked eye is apt to lead to errors. Coke flame is brighter than coal flame but that does not prove that its temperature is higher, because the coal flame is rendered somewhat darker by the presence of decomposing hydrocarbons and carbon particles resulting from this decomposition.

The greatest trouble was experienced in attempts to burn coke on traveling grates which had been designed mainly to

take care of fuels rich in gas, but not those containing little or practically no gas, such as coke. There must be found therefore some other way of igniting the fuel coming into the furnace than by the use of a zone of incandescence produced by a glowing arch. This seems to have been accomplished by engineer Belani, of Essen, Germany. In his arrangement shown in Fig. 5, there is provided a sort of pre-ignition where the coke is ignited before it reaches the traveling grate, which makes the action of the arch entirely superfluous. The pre-igniting device which supersedes the usual fuel supply hopper and has about the same dimensions as the latter, consists of a funnel shaped shaft, lined with fire bricks, equipped at the front with an inclined grate and connected on the other side by a passage with the fire chamber of the boiler. Under this connecting passage there is provided a slide valve regulating the height of fall of the fuel. The device is operated as follows:

First, the furnace is filled as far as the grate bars with coke which has been previously brought up to a state of incandesence. Then the entire hopper shaft is filled with fresh coke. As a result of the chimney draft, air is drawn in between the grate bars and through the glowing layer of coke, while the gases of combustion generated there go through the passage above referred to, directly into the boiler furnace. As the parts of coke lying on the traveling grate in a state of incandescence are drawn away, fresh coke is supplied from the hoppers.

Tests of this apparatus are said to have given satisfactory results. (*Die Verwendung von Koks zur Dampferzeugung*, Dr.-Ing. H. Markgraf, *Stahl und Eisen*, vol. 35, no. 33, p. 847, August 19, 1915, 6 pp., 2 figs. *o.*)

ENGINEERING SOCIETIES

AMERICAN INSTITUTE OF MINING ENGINEERS

Bulletin, no. 105, September 1915, New York City.

Manufacture and Tests of Silica Brick for the By-product Coke Oven, Kenneth Seaver (abstracted)
Mine Pumping, Charles Legrand (abstracted)
Conveyor Belt Calculating Chart, J. D. Mooney and D. L. Darnell (abstracted)
Ventilation of the Copper Queen Mines, Charles A. Mitke
The Stresses in the Mine Roof, R. Dawson Hall
Standardizing Rock Crushing Tests, Myron K. Rodgers

MANUFACTURE AND TESTS OF SILICA BRICK FOR THE BY-PRODUCT COKE OVEN, Kenneth Seaver

The paper describes methods of manufacture and testing for the determination of effects of burning of silica brick.

American practice in the manufacture of silica brick is far above that of any other country. As the author states, in some instances, European manufacturers have refused to credit the possibility of making to such specifications as are common in this country until the actual completed shapes were shipped for inspection.

By silica brick, the author understands only a brick having a silica content of 94 per cent or more and made usually from quartzite with a small percentage of lime as a binder. He discusses in detail the materials used, such as Pennsylvania, Wisconsin and Alabama quartzite, and its various stages of manufacture, such as quarrying, grinding, molding and burning, and, in the latter connection, gives data concerning the effect of burning on composition, expansion and physical strength of the brick. He comes to the conclusion that while by quick burning, brick may be easily expanded to double or treble the normal amount, this is not conducive to the production of sound brick. In general, he believes that the present good commercial practice carries the results of the quartz-cristobalite inversion to the greatest degree economically possible. He reports also a series of tests having for their primary object the determination in how far the inversion from quartz to cristobalite has progressed under various conditions. (14 pp., 3 figs. *ep.*)

MINE PUMPING, Charles Legrand

This paper is a discussion of the questions of mine pumping, such as the selection of proper pumps under various conditions, the design of the pump, especially its piston and packing, and the selection of the driving plant and transmission. A number of tests are reported in tabular form on several sizes of steam and electric pumps, as well as on air lifts. With the latter, in the best test for 200 ft., 1680 gal. per min. of water were delivered. (6 pp. *e.*)

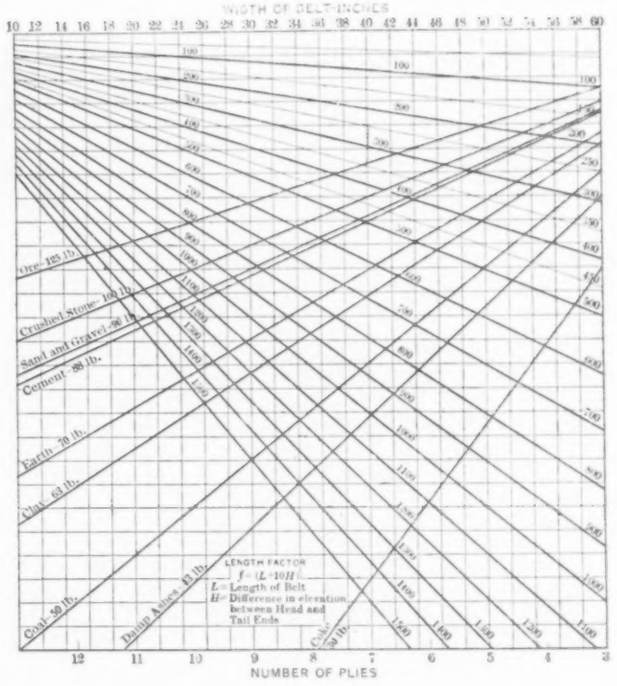


FIG. 6 CONVEYOR BELT CALCULATING CHART

CONVEYOR-BELT CALCULATING CHART, J. D. Mooney and D. L. Darnell

The chart shown in Fig. 6 has been drawn as a means to determine quickly the correct number of plies of conveyor belts operating under specific conditions. The calculations are based on the average safe strength (factor of safety of 15) of the various standard rubber conveyor belts. The calculations assume a maximum load condition, i.e., the belt is considered as carrying the greatest load that it will handle without spillage at ordinary belt speeds, which produces the most economical operating conditions and maximum tension in the belt. The chart represents graphically the formula

$$p = kgW(L + 10H)$$

where p = the correct number of piles; k = constant de-

pending on the type of drive; g = the weight in pounds per cu. ft. of material handled; W = width of the belt in inches; L = length of the belt in feet, approximately twice the center distance; H = the difference in elevation between the head and tail pulleys in feet.

For a simple drive, with a bare pulley, $k = 1/250000$; for a simple drive with a rubber-lagged pulley, $k = 1/300000$; for a tandem drive with bare pulleys, $k = 1/375000$ and for a tandem drive with rubber-lagged pulleys, $k = 1/455000$.

The chart is drawn for a simple drive with a bare pulley and therefore the number of plies obtained from the chart should be multiplied by the factor 0.83 or 5/6 for simple lagged drive; a factor of 0.67 or 2/3 for tandem bare and a factor of 0.55 or 11/20 for tandem lagged drive.

The length factor $f = L + 10\ H$, represented on the chart by the lines 500, 600, etc. is a developed factor equal to the sum of the length of the belt and 10 times the difference in elevation between the head and tail pulleys.

To find the correct number of plies for a conveyor belt, knowing the width, length, difference in elevation between the head and tail ends and the kind of material to be handled, start from the width given at the top of the chart and move downward until this line intersects the line corresponding to the proper length factor; then move either right or left until the line corresponding to the given material is met; then move down again to the scale of plies where the next largest figure will give the desired correct number.

For example, to find the correct number of plies for a conveyor belt 36 in. wide and 300 ft. long, with 20 ft. difference in elevation, handling sand and gravel, follow the 500 length line; then follow to the right until the "sand and gravel line" is intersected; then down to the ply scale where the ply will be found to be 7. (3 pp., 1 fig. *p.*)

AMERICAN SOCIETY OF NAVAL ENGINEERS

Journal, vol. 27, no. 3, August 1915, Washington, D. C.

Heat Losses in Steam Transmission, W. L. Catheart (abstracted)
Manganese-Bronze, Lieut. J. B. Rhodes, U. S. N.
Method of Testing Safety Valves at the U. S. Naval Experiment Station, Ensign L. R. Ford, U. S. N. (abstracted)
Land Storage of Bituminous Coal, Geo. R. Crapo, Paymaster, U. S. N. (abstracted)

Heat Losses In Steam Transmission, W. L. Catheart.

General discussion of heat losses in steam transmission, both for superheated and saturated steam.

The question of radiation and conduction is discussed from the point of view of the Stefan-Boltzmann law of radiation (in which the radiation of a black body is proportional to the fourth power of its absolute temperature).

For the external conduction, the author establishes formulae based on the general method of Mollier, the transfer of heat from one fluid to another, through an intervening solid, being divided into three stages: External conduction from the first fluid (steam) to the solid (pipe metal); internal conduction through the latter; and external conduction from the pipe to the second fluid (air). From the data obtained in Eberle's tests, the author calls attention to the fact that there is a marked difference between the values of k_1 (coefficient of external conductivity of steam to plate) for superheated and saturated steams. Saturated steam cannot lose heat without partial condensation and hence there is not only a film of condensate adhering to the interior surface of the pipe, but probably the column of moving steam has also a thin casing of condensate. The usual formulae do not consider these insulating films, since the heat transfer through them is too complex a process. With highly superheated steam, these conditions do not prevail, since the pipe, if properly protected, is hotter than the corresponding temperature of saturated steam.

The author reports fully the Péclet formulae for heat losses, both by radiation and by conduction. The heat losses of saturated steam in uncovered pipes are discussed in detail and a table is given where there are assembled data of 19 of the principal tests of uncovered pipes containing saturated steam. In this table are given the total losses as computed by Péclet's formula, and it is shown that the average correction to be applied to the latter is 0.3. The necessity for the correction is explained by the fact that the Péclet results were derived from laboratory experiments on apparatus of limited size, while under practical conditions, the condensate method involves possible errors.

The heat losses of covered pipes are likewise discussed. The article is of interest as giving a very clear presentation of a very important subject, combining data from the best sources (26 pp., *gt*).

Method of Testing Safety Valves at the U. S. Naval Experiment Station, L. R. Ford.

The article describes the method of testing safety valves at the United States Naval Experiment Station and in particular, the testing of the safety valves on the U. S. S. Nevada.

The requirements for safety valves are briefly reported and the experimental arrangement described in detail. The tests of springs are described in particular. The maximum fibre stress in the spring occurs at the middle of the inside edge of section of the spring coil and is made up of the four component stresses due to torsion, direct shear, bending and direct compression. The effect of the last two is sufficiently slight to be neglected. The first two produce a maximum shearing fibre stress, which is calculated for a valve lift of 0.100 in. by the following formula:

$$S = \frac{9Q\cos\theta R}{2bh^2} + \frac{Q\cos\theta}{A}$$

where Q = load on spring in pounds; R = the mean radius of the coil measured from the axis of the spring to the center of gravity of sections in inches; θ = the angle of inclination of coil to a plane perpendicular to the axis of the coil. The shearing modulus of the spring material is calculated for a valve lift of 0.100 in. by the following formula

$$d = \frac{Q\cos^2\theta R^2 L}{CJG} + \frac{Q\cos^2\theta L}{AG}$$

in which d = axial deflection per coil in inches
Q = load on spring in pounds
R = mean radius of coil in inches by measurement
p = pitch of coils in inches
$L = (p-d)^2 + (2\pi R)^2$ = length of one free coil in inches actively opposing the compression of the spring

$$\cos\theta = \frac{2\pi R}{L}$$

C = St. Venants constant for the resistance to torsion of bars of nearly square section

$A = h \times \frac{B+b}{2}$ = area of section in square inches

h = altitude of trapezoidal section in inches

B = larger base in inches

b = smaller base in inches

$J = \frac{h}{48}(B^3 + B^2b + Bb^2 + b^3) + \frac{h^5}{36}\left(\frac{B^2 + 4Bb + b^2}{B+b}\right)$ = polar moment of inertia of trapezoidal section in inches

G = shearing modulus of elasticity in pounds per square inch (12 pp., 4 fig., *ed*).

LAND STORAGE OF BITUMINOUS COAL; THE EVER PRESENT FACTOR OF SPONTANEOUS COMBUSTION; AND A FEW FACTS AND SUGGESTIONS IN CONNECTION WITH SAME, Geo. R. Crapo.

The writing of this article was prompted by the fact that from November 15, 1914, to February 20, 1915, a series of fires of a spontaneous nature, sixteen in all, took place in the coaling plant under the charge of the writer, at the Naval Station, Key West, Fla. From what appears in this connection, it seems that this matter of spontaneous ignition of coal is of far greater importance than is generally realized.

The plant at the Naval Station, Key West, Fla., consists of two steel sheds, one 150 x 100 x 20 ft. at the eaves, and the other 250 x 75 x 20 ft. at the eaves. From the above dimensions, using 42.5 as the average density of coal, it is seen that the plant was built for the purpose of storing 15,883 tons of coal within ready reach of the conveyors for rapidity of handling.

The best authorities contend, however, that coal cannot be safely stored at a depth of over 14 ft. and even at that depth, a careful watch must be kept constantly on it. This means that the plant, designed to store nearly 16,000 tons of coal in such manner that rapid discharging and loading of vessels can be effected, can be used only for the storage of 11,000 tons; it again means that if in case of war, the plant is called upon to work to full capacity and the coal is urgently needed, it would either be too hot to place safely in the vessel's bunkers, or the prolonged and continual heating would have so exhausted its calorific qualities as to render it poor steaming coal. It appears, therefore, that something is radically wrong; either the adopted system of storage or our lack of information on a subject of this importance.

The author discusses the conditions contributing to the ignition of coal. He calls attention to two very simple tests, showing in advance whether or not the coal in question can be safely stored. One of these tests is given by Professor Fisher, of Göttingen, as follows:

> Coals which absorb bromine rapidly are most liable to spontaneous ignition. Shake one grain of finely ground coal with 20 cc. of a half normal solution of bromine for a period of five minutes. If the smell of the bromine has then disappeared, the coal is likely to oxidize rapidly and is not a safe one to store.

Professor Lewes gives the following test:

> Coal that gains more than 2 per cent in weight when heated to 250 deg. fahr. for three hours, is a very dangerous coal to store.

The author discusses in detail the supposed causes of ignition. He comes to the conclusion that an open shed with just enough superstructure to support the overhead mechanical devices for use in the handling of the coal, is far superior and safer than the closed type. He does not believe that coal exposed in open air for, say one year, will lose all of its calorific properties. The Florida East Coast Railway and several shipping and commercial concerns keep varying quantities of coal at Key West in the open, often for considerably over one year, and the coal gives good average results for steaming purposes.

The overhead conveyor system, with the apron perhaps from 45 to 60 ft. above the floor of the shed, is very bad practice, *first*, because coal in its fall generates additional heat and before this heat can escape, another bucketful is dropped upon the first, and *second*, the coal falling from this height, breaks a large percentage of the lumps and creates more fine coal dust, which, in itself, is a dangerous element.

Too great dependence should not be placed on the temperature readings (which the author, however, strongly recommends to be made), as it very frequently happens that that portion of coal which fires first is not the portion which indicates the highest thermometer reading; often the portion first heated may get a draft of air in consequence of the heating and the heat then move and deposit elsewhere.

A promiscuous use of water in extinguishing fires in a coal pile is of practically no value. A coal pile will often heat almost to the point of coking and then subside, but if water is used at that stage, the coking will take place at once and coal will be lost which otherwise might be saved (12 pp., 1 fig., *gp*).

CANADIAN RAILWAY CLUB

Advance publication of paper read on September 14, 1915.

HYDRAULIC PRESSES VERSUS POWER PRESSES FOR THE MANUFACTURE OF CARTRIDGES AND SHELLS, Wm. Rodger.

The author discusses the question whether hydraulic or power presses are the more economical and efficient for the manufacture of cartridges and shells. He considers four types of presses: Steam Pump Presses, Hydraulic Presses, Motor Driven Power Presses and Direct Steam Presses.

Steam Pump Presses. Boilers are required to generate steam for the pumps and the pumps must be large enough to supply the water at the pressure and velocity to keep the accumulator up when the presses are in operation. A receiving tank, having direct connection with the water main, is also absolutely essential. With this type of press economy in steam power can be obtained by the use of a trip valve, operated automatically, which cuts off the steam when the press is not in operation. It is good policy to make the pumps 25 per cent larger than is actually required, as at times the pump is liable to give out with overload on the press.

Hydraulic Presses. In the case of a hydraulic press, the position of the presses should be determined relative to the pump and to the accumulator in order that the pipes may be arranged to eliminate right-angle bends, for the purpose of preventing sudden shocks and bursting of pipes, which would materially retard the output. In the manufacture of cartridges and shells, the writer is convinced that the use of an accumulator is indispensable; for example, should a triplex

pump, which gives a more even flow of water pressure, be used, a certain loss of energy would manifest itself; consequently, the pressure at the press would be oscillating in character, but this would be obviated by the use of an accumulator. It is often advisable to operate a press or other hydraulic tool direct from a pump without the use of any interposed accumulator, but for this special work it is essential that the accumulator be employed to give the desired results, as without its use any pressure from 1500 lb. per sq. in. upwards could be obtained without any means of regulation of the pressure.

A motor driven pump consists of a hydraulic plant operated by steam supplied to an electrical generating set, which in its turn supplies current to the motor driving the power pump; the electrical generating outfit being a high speed engine and having a short cut-off, it will use less steam and consume less fuel.

Motor Driven Power Presses. In the opinion of the writer the best method of placing the motor is to drive onto a countershaft, which, although it necessitates a special self-starting rheostat, permits the press to be driven by a smaller motor as the load or torque of the motor is overcome by the countershaft.

Direct Steam Presses. The direct steam press is not suitable for shell and cartridge making, as it is not possible to attain the required pressure per square inch at the back of the piston (11 pp., *p*).

CORPS OF ENGINEERS, UNITED STATES ARMY

Professional Memoirs, vol. 7, no. 35, September-October 1915, Washington Barracks, D. C.

The Diesel Engine, Capt. John M. Wright
Butterfly Valve Experiments, Lieut. Col. Charles Keller (abstracted)
The Use of Outlets for Reducing Flood Heights, J. A. Ockerson
A Season with the Cement Gun, Major W. G. Caples

Description of Tests of Butterfly Valves on Locks in the Black Warrior Region, in Alabama.

On the system of locks on the Warrior and Tombigbee Rivers, all the culverts except two are controlled by butterfly valves, either in pairs or in sets of three. These valves are set with their axes vertical, and are operated by hand through a simple worm and sector. On the whole, they have given satisfaction, but certain difficulties in their operation have led to the tests described in the article, and proper changes followed as a result.

The first eight locks built on the Warrior and Tombigbee Rivers were equipped with pairs of butterfly valves, 6 ft. 0 in. high, 2 ft. 10½ in. wide, operated from the tops of the walls. At three of these locks, each valve was set in an independent frame and operated as a single unit by a simple lever keyed to the top of the shaft. At the other five locks, the valves were operated in pairs by a worm and quadrant gear. With three valves thus connected to a worm and gear device, it was found that the total moment which one man could exert was 58,020 in.-lb., or 19,340 in.-lb. to each vertical shaft, which was not enough with heads of over 10 ft. to permit a single operator to open a set of three valves to normal position.

The difficulty of operating three valves keyed to a single hand wheel was attributed to two causes: *First,* when two or more valves are operated simultaneously, the water deflected from the first or upstream valve, when partly open, comes in contact with and tends to close the second valve; the stream deflected from the latter offers a similar resistance

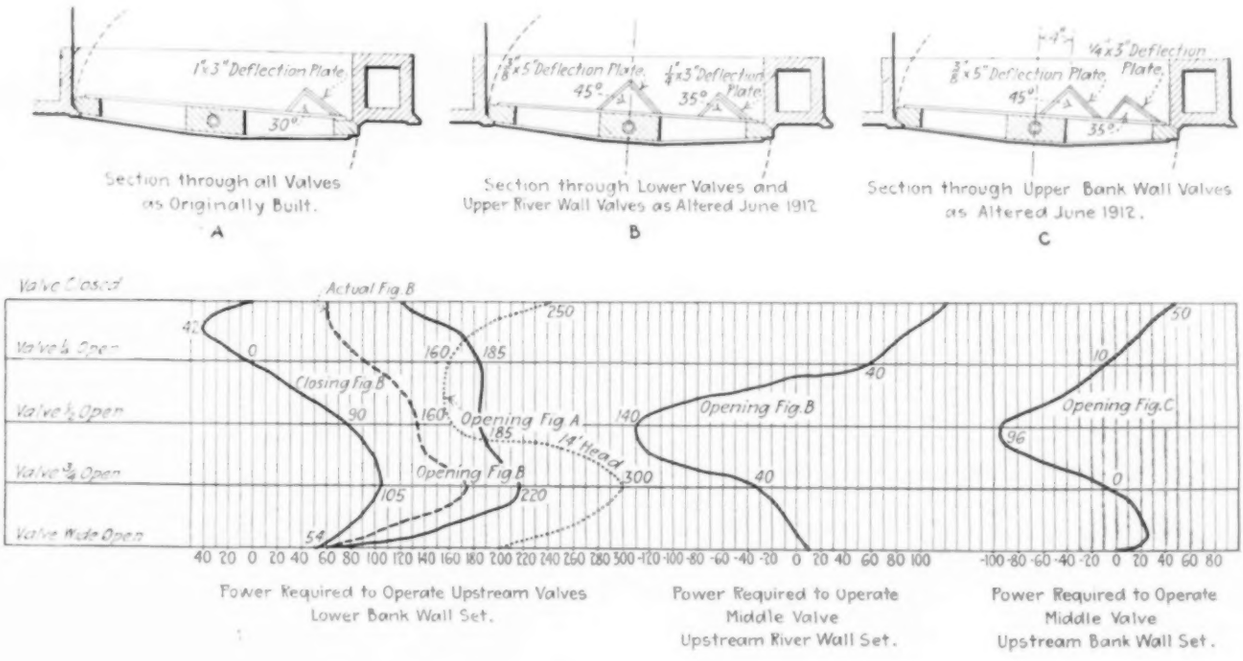


Fig. 7 Butterfly Valve Experiments

to the opening of the valve next down stream. *Second,* the valve divides this stream moving into the valve opening and the portion of the current down stream of the valve is deflected by the valve body. The eddy motion thus caused may produce a reverse pressure on the inmoving or down stream side of the back plate of the valve near the culvert floor, this also tending to close the valve.

Various deflection plates or partitions were installed and in August, 1911, a series of tests was made to ascertain the effect of these various arrangements of deflection plates applied to butterfly valves of the kind above described. The tests were made on a quarter side valve carefully built of steel.

A comparison of the curves of the first diagram of Fig. 7 for a lower valve with those for an upper valve (B and C) shows a material difference in the curves, which is due to the absence of backwater in the upper culvert. This again shows that the sheet of water entering when the valve is "cracked" is deflected free of the inturning half of the lift by the second deflection plate, Fig. B, which causes the valve to slam open. As a result of this test, it was decided to add to all butterfly valves then in service, in addition to the 3-in. deflection plate originally provided, a second plate 5 in. wide, screwed to the back of each valve with horizontal angle of 45 deg. between them and with the outer edge 4 in. upstream from the center line of the back plate, as shown in "C," top Fig. 7. The additional deflection plate, combined with certain partitions between the valves, has made it possible for one operator to open to normal position the three valves of one side simultaneously and under full heads up to 21 ft. (4 pp., 4 plates, *ed.*)

UTAH SOCIETY OF ENGINEERS

Vol. 1, no. 8, August 1915, Salt Lake City, Utah.

THE RELATION OF STREAM GAGING TO THE SCIENCE OF HYDRAULICS, C. H. Pierce and R. W. Davenport

The article represents a general discussion of the modern tendencies in the development of the science of hydraulics as affected by the work done in stream gaging, especially in connection with various irrigation problems in the United States and also by the United States Geological Survey.

The author believes that methods for the measuring of discharge, such as the use of salt or other chemicals, or the use of a diaphragm in open channels of uniform cross-section, are likely to become increasingly valuable, but as with the use of the weir, they probably will not be universally applicable as means of measurement. The current meter is undoubtedly founded on the right principle and it is hardly conceivable that it will be superseded.

A study of the evolution of stream gaging shows the important part played by empirical developments together with scientific research, and it is even conceivable that in time the same results might have been obtained through empirical processes alone. This fact is illustrated by some features of the present method of stream gaging. The observations of velocities at six-tenths and two-tenths of the depth have resulted from a large number of experiments, but it is now a well known fact that these methods are supported by the form of the vertical velocity of curve, which is that of the parabola; in fact, the author criticises somewhat the development of the present studies of stream gaging, in that possibly too much reliance has been placed on empirical methods and the advantages to be gained from scientific analyses have been given too little recognition.

Theoretical considerations embraced under the science of hydraulics, constantly appear as supplementary to the practical applications. For example, a thorough knowledge of Chézy's formula may often be of great practical use in analytical studies of stream flow data, although the field of direct application of the formula is limited.

The drainage investigations which have recently been undertaken in some of the Southern States for the purpose of reclaiming thousands of acres of rich agricultural lands afford an excellent illustration for the need of stream gaging of a high degree of precision. Many valuable experiments tending to increase the knowledge of hydraulic phenomena have been carried out in connection with irrigation work in the arid regions where, in some special investigations with comparatively small quantities of water, volumetric methods were used. In the work of the United States Reclamation Service, the science of stream gaging has been applied to a large number of problems, such as determination of friction losses in large size wood-stave pipe; values of the coefficient of roughness for different materials; proper coefficients to be used in computing discharge through gas; efficiency of pumps and turbines and economic size and cost of power plants for pumping water for irrigation.

The author comes to the general conclusion that a large amount of research is yet needed before hydraulics can become an exact accepted science, but the recent developments in stream gaging point to the possibility that this branch of hydraulics may in time reach a state of perfection such that all problems connected therewith may be solved with mathematical exactness and the term "probable error" be reduced to a rational quality. (8 pp., 1 fig., *g.*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles in the Survey.

NECROLOGY

R. PAUL STOUT

R. Paul Stout was born at Bethlehem, Pa., in 1869. He was educated at a private school at Audenried, at the Hill School of Pottstown, and later at Lehigh University, from which he was graduated in 1891 with the degree of Mechanical Engineer. During vacation periods, he served as a machinist in the shops of the Janesville Iron Works.

His first position after graduation was that of mechanical engineer with the Lehigh & Wilkes-Barre Coal Company at Audenried. He entered the employ of the Bethlehem Steel Company as assistant superintendent of the armor plate department in 1894, when the armor for the United States battleships *Brooklyn, Oregon, New York* and *Iowa*, and the Russian ships *Petropovlovsk, Admiral Siniavan, Admiral Oushakoff* and *Rostislav*, and also the first large armor plate vault for the Philadelphia Savings Fund Society, was being manufactured by the company. During this time, too, face-hardened armor was first manufactured in this country and the best Harveyized armor in the world up to that period was developed at the Bethlehem plant.

In August, 1897, on the formation of the Bethlehem Company's ordnance department, Mr. Stout was transferred to that department and two years later he assumed charge of the development of the first piece of ordnance mechanism of its own design which the company sold. Under Engineer of Ordnance Lieut. Meigs, he had charge of all the experimental and development work in this department until September, 1910, when he himself was appointed Engineer of Ordnance, which position he held up to the time of his death. Within his period of service in this capacity, the company secured the largest naval ordnance order placed in this country, in the complete ordnance equipment and armor for the Argentine battleships *Moreno* and *Rivadavia*, and it was in the last two or three years that the company attained its present position in the manufacture of all kinds of ordnance and munitions.

Mr. Stout was elected to membership of the Society, member grade, in 1906. He was also a member of The Franklin Institute. He was killed on August 25 as the result of the accidental detonation of a high explosive shell.

JOHN CHARLES WILLIAM GRETH

John Charles William Greth was born in Buffalo, N. Y., in 1874. He attended the public schools of that city and was graduated from the Buffalo Central High School in 1893. In the same year he entered Cornell University and was graduated in 1897 with the degree of Mechanical Engineer. After graduation he began his engineering work by installing and operating for a few months a power plant at a summer resort on Lake Erie. From 1898 until 1902 he successively installed pumping machinery, designed special machinery, operated a power plant and installed and operated refrigerating and ice making plants.

In 1902, he entered the service of Wm. B. Scaife & Sons Co., Pittsburgh, Pa., as manager of the water softening and purification department, and from that year until his death his time was devoted to the development of apparatus and methods for the softening and purification of water for all purposes.

Mr. Greth took out sixteen patents on improvements in water purifying apparatus, several of which embodied radical features. He occupied a leading position in the field of water purification and his forceful presentation contributed very materially to the advancement of the science and application of water purification for industrial use.

Mr. Greth was the author of a number of articles on water purification published in the engineering press and he read several papers on the same subject before various engineering societies. He was recognized as an expert in water purification by engineers and chemists and his integrity gained for him a wide circle of friends.

He was a member of the American Society of Civil Engineers, the American Institute of Chemical Engineers, Engineers Society of Western Pennsylvania, and of the American Chemical Society.

He was elected a member of the Society in 1907. He died at Gibsonia, Pa., on August 7 after a short illness.

HERBERT GRAY TORREY

Herbert Gray Torrey was born in New York in 1839. He was educated in the College of the City of New York, from which he was graduated in 1860. He became the assistant of his father, John Torrey, who was the first chief assayer in the U. S. Assay Office in New York City, and he succeeded his father at the latter's death in 1873. He served as chief assayer until 1910, when he went into private practice, becoming president of H. G. Torrey and Co., assayers and metallurgists; he retired in 1912.

Mr. Torrey was also a consulting chemist, a specialist on alloys and a government expert in textile fabrics and an examiner of mines. He maintained a private metal shop at Stirling, N. J., manufacturing magnolia metal. He invented Torrey metal, an anti-friction alloy.

He was a member of the Society of the Cincinnati, the American Institute of Mining Engineers and The Franklin Institute. He became a life member of the Society in 1890. He died at his home at Stirling on August 29.

PERSONALS

Gilbert R. Haigh has recently become associated with A. D. Wilt, Jr., of the Wilt Twist Drill Company of Walkerville, Ontario, Canada, in drill manufacture and industrial engineering.

Carleton Wandel, formerly associated with the New York Central and Hudson River Railroad, West Albany, N. Y., has accepted a position with E. W. Bliss Company of Brooklyn, N. Y.

C. R. Cady has accepted a position with Smith, Hinchman and Grylls, Detroit, Mich., as industrial engineer. He was until recently affiliated with the Celfor Tool Company of Buchanan, Mich.

William J. Sweetser, until recently assistant professor of mechanical engineering at Case School of Applied Science, Cleveland, O., has been appointed professor of mechanical engineering at the University of Maine, Orono, Me.

Emile J. Bayle has resigned his position as general engineer of the American Beet Sugar Company, Denver, Colo., to accept the position of production manager for the Aluminum Castings Company, at their Detroit plant.

James A. Hall has resigned his position as draftsman with the Link-Belt Company, Philadelphia, Pa., to take up the assistant professorship in mechanical engineering at Brown University, Providence, R. I.

H. Owesen has severed his connection with the Standard

Steel Car Company, Butler, Pa., as assistant chief draftsman of the die department, and has accepted a position with the Carnegie Steel Company, Homestead, Pa.

William E. Moore has resigned his position with the West Penn Traction and Water Power Company Properties, Pittsburgh, Pa., as vice-president and general manager, and will open offices in Pittsburgh as consulting engineer.

Arthur F. Murray, formerly associated with the International Steam Pump Company, St. Paul, Minn., has become connected with The Blake and Knowles Steam Pump Works, East Cambridge, Mass., as equipment engineer.

M. William Ehrlich has severed his connections with Cole, Ives and Davidson, after two and one-half years of service, and has taken up the duties of editing *Electrical Engineering*, a monthly paper devoted to the field of electric practice, with headquarters in New York City.

Burt D. Thompson has become associated with the Curtiss Motor Company of Hammondsport, N. Y., as production manager. He was until recently foreman of machine shop of the National Twist Drill and Tool Company, Detroit, Mich.

William T. Clark has accepted a position with the Automatic Machine Products Company, Brooklyn, N. Y., as general manager. He was formerly connected with the Enterprise Manufacturing Company of Pennsylvania, Philadelphia, Pa., as manufacturing manager.

G. D. Bradshaw, steam engineer of the Cambria Steel Company, has tendered his resignation and on October 1 will enter business for himself at Pittsburgh under the firm name of Andrews-Bradshaw Company. Mr. Bradshaw has been in the Steam Engineering Dept. of the Cambria Steel Company for the past five years. Prior to that time, he was employed by the Indiana Steel Company at Gary for one year, and by the Illinois Steel Company of Chicago for five years.

R. S. Farr has been appointed instructor in mechanical drawing and design at the Towne Scientific School of the University of Pennsylvania, Philadelphia, Pa.

Frederick H. Moody has left for active service as an infantry captain, second in command of No. 4 company, 83rd Battalion, Canadian Expeditionary Force. He has been nine years in the Canadian Militia, five years in the ranks in the Engineers, and four years as a commissioned officer in the Queen's Own Rifles of Canada.

Louis J. Illmer Jr. has accepted a position as chief engineer of the Lake Heat Engine Company of Bridgeport, Conn., developing Mr. Simon Lake's inventions and ideas as applied to Diesel engines for submarine drives.

William F. Turnbull has been appointed instructor in mechanical drawing and design at the Towne Scientific School of the University of Pennsylvania, Philadelphia, Pa.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to be the medium of assisting members to secure positions, and is pleased to receive requests both for positions and for men. Copy for the Bulletin must be in hand before the 18th of the month.

POSITIONS AVAILABLE

The Society acts only as a "clearing house" in these matters and is not responsible where firms do not answer. In sending applications stamps should be enclosed for forwarding.

0244 Machine shop foreman between 25 and 35, capable of handling about 50 men. Experience with agricultural implement parts preferred. Salary $110 to $125. Location Pacific Coast.

0245 Storekeeper between 35 and 40, with at least three years' experience in charge of store department. Conscientious man required. $125. Location Pacific Coast.

0246 In engineering department for young college graduate M.E. with one or two years' experience in shop practice or in time study. Salary according to qualifications. Location Maine.

0248 Large concern in Central New York State, manufacturing pumping machinery, has vacancies for technical graduates interested in taking student's course in shop and testing department. Compensation 25 cents per hour for 55 hour week. Work leads directly to sales department where advancement depends on ability shown. Reply by letter.

0249 Draftsman, machine tool worker, jigs, dies, etc. Some shop experience preferred. Give age, experience and salary expected. Location East Chicago, Ind.

0250 General electrician to take charge electrical department of cement plant. To be working foreman when necessary and superintend three electricians and two motor attendants. Repair, construction and transmission work necessary. Salary $150. Location Southern States.

0251 Mechanical engineer experienced in designing and building special machinery for manufacture of paper goods and printing, to take charge of drafting room and large machine shop of 1000 machine capacity. Splendid opportunity for right man. Apply by letter, stating experience and expectations.

0253 Capable machine tool designer with 15 or 20 years' practical experience in shop and drawing room, to design lathes and turret machinery from 1500 to 4000 lb. Location New York State.

0255 A state university needs two competent instructors in mechanical engineering. Excellent practical and preferably teaching experience desired. One in machine design, other in mechanical engineering laboratory practice and steam engineering. Send full statement of training and experience, with list of references and recent photograph. Salaries according to qualifications. Location Central States.

0256 Designer and constructor of steam and centrifugal pumping machinery. Man who can take charge of department in small factory. $35 to $40 per week, with possibility of advancement. Location Michigan.

0259 Large casualty company has opening in its steam boiler and flywheel insurance department for special agent and solicitor. Insurance experience unnecessary and the company would be glad to receive applications from men with selling experience in mechanical lines and familiar with steam plant operation. $100. Location New York.

0261 Two or three first class mechanical draftsmen, competent to lay out and develop plans in detail of wood and steel brake construction. Location Scranton, Pa.

0265 Thoroughly practical mechanic who has had considerable shop experience, and has executive ability. Prefer young man. Location Ohio.

0268 Designer of crushing, conveying, elevating and mining machinery. Salary $40 per week. Location New York.

0269 Junior draftsman on same work as 0268. Salary $25 per week. Location New York.

0270 Combustion engineer, with practical and technical experience with boilers, stokers and auxiliaries. Knowledge of boiler and refrigerator testing, power plant work. Give references and salary expected. Location New Jersey.

0271 Wanted, a mechanical engineer salesman, by firm with business in various parts of Spanish America, handling mining, agricultural, power plant and railway machinery. Must be a native of the U. S. and a graduate mechanical engineer with degree from a U. S. college or university. Not under 30 nor over 45. Ability to write specifications on pumps, steam power plant equipment and locomotives; successful experience as salesman; good address and appear-

ance essential. Must speak and write Spanish well. Apply by letter.

0274 General superintendent to develop machine factory; thoroughly practical and responsible and in position to systematize special automatic machines. Knowledge of paper products and German language essential. Salary according to qualifications. Location Hoboken, N. J. Apply through Society.

0277 Recent graduate with practical experience and adaptability for research work required as assistant to testing engineer. Salary $80 to $100 to start, depending upon ability and experience. Location New Jersey.

MEN AVAILABLE

The published notices of "men available" are made up from members of the Society. Notices are not repeated in consecutive issues of the Bulletin. Names and records are kept on the office list three months, and at the end of such period if desired must be renewed.

J-269 Student member, 1915 Columbia University graduate M.E., desires a position in or around New York which offers an opportunity to start in the engineering profession. Salary to start secondary consideration.

J-270 Ordnance engineer, member, M.E. degree 1913, age 35, married, fourteen years' experience, five and one-half years in army ordnance department, three and one-half years captain of coast artillery, completed ordnance school of application, familiar with electrical machinery and gas engines, commended for management and also familiar with efficiency systems, desires administrative position in development of military manufactures.

J-271 Designer of automatic machinery and general engineering is open for position.

J-272 Member, graduate engineer, age 35, American, capable designer, practical foundry and shop man, experienced in modern production, methods and management, has had broad engineering experience in Europe and America as mechanic and executive in design and manufacture of engines, heavy machinery, machine tools, automatic machinery and light grade specialties, desires position as chief engineer, superintendent, manager or assistant. Location immaterial, salary commensurate with position.

J-273 Mechanical engineer, five years' practical experience in steam turbines, power plant equipment and layouts; also reinforced concrete and construction work. Future opportunity considered before salary. No preference to location. At present employed.

J-274 Member, technical graduate, age 34, experienced in editorial and publicity work, can write forcefully and with exceptional ability in attractive arrangement of copy, desires position as assistant to advertising manager.

J-275 Member, mechanical engineering graduate of Worcester Polytechnic Institute, age 26, two and one-half years' experience in engineering department of a large steel plant, wishes to make a change and become permanently connected with a New England company or firm where he can learn the business and become of value to it.

J-276 Graduate M.E., age 31, well posted on pumps and pumping machinery of all types, oil, gas and steam engines, drawing room and shop practice, sugar house work in Mexico and sales engineer in Brazil, desires permanent employment with reliable firm either in sales, office or shop. At present employed as salesman and expert on farm machinery.

J-277 Mechanical electrical engineer, age 32, married, with five and one-half years' experience on the design and installation of all kinds of factory equipment, and the practical application of the principles of scientific management, desires a change. First class man on time study standardization and systematizing. Salary $2400.

J-278 Member, age 35, with an unusually thorough experience in rubber mill engineering, including developments, reports, designs, specifications and contracts for buildings, power requirements and manufacturing equipment, desires position with consulting engineer or large rubber mill. Salary $4000. At present employed.

J-279 Technical graduate, M.E., age 28, experienced in shop and drafting room, elevating and conveying machinery, desires position as draftsman or designer with good chance for advancement.

J-280 Junior member, Columbia graduate M.E., 1913, two years' experience in production and drafting department, desires position in New York with chance for advancement. At present employed.

J-281 Associate-member, age 33, with experience as sales engineer and in charge of sales in specified territory, of air compressors, refrigerating and pumping machinery, including layout and installing, desires position as local sales manager with headquarters in Chicago. Prefers to associate himself with manufacturer who is looking for a considerable increase in sales and needs a capable and conscientious representative to obtain such a result.

J-282 Associate-member, age 34, technical and practical training, specialized in manufacturing of cement, ten years' experience designing, building and operating crushing and cement plants, two years' selling experience, desires position as sales engineer with concern manufacturing machinery for cement and crushing plants, or accessories connected with the industry.

J-283 Member, age 32, married, who has held positions from shop errand boy to present position of general manager, wishes to become connected with large industry or undertaking; thoroughly acquainted with automobiles, has traveled extensively and has had charge of men for fifteen years. Would like to be assistant to general manager, but would consider any position that would make advancement possible. Willing to go anywhere but prefers New York, Detroit, Chicago or vicinity.

J-284 Associate-member, age 26, married, nine years' experience machine shop, foundry and general engineering practice. Has filled position of engineer inspector to large inspection bureau handling large government and private contracts comprising all kinds of mechanical construction. Desires change to avoid continual travel and wishes position as assistant engineer, superintendent or production engineer. Location immaterial.

J-285 Mechanical engineer, age 33, married, graduate of leading engineering college, twelve years' practical experience, chiefly in the manufacture of boilers and general plate work in engineering and executive positions. Would be valuable as manager, assistant manager or chief engineer. At present employed.

J-286 Associate-member, broad experience in operating, thoroughly versed in power plant economies and qualified to design power houses, or operate existing plant to obtain maximum efficiency, desires position as chief engineer of power plant. At present in charge of power end of large automobile factory. Speaks Spanish.

J-287 Associate-member, age 27, married, Cornell, M.E., five years' experience in construction and operation of hydroelectric plants, large part of the time executive in responsible charge, desires position. Now employed in Utah but desires residence in lower altitude.

J-288 Junior member, M.E., age 27, seven years' experience in design of gasoline and kerosene engines, jigs, tools, power plant installations, and general equipment, desires position with reliable manufacturing or engineering concern.

J-289 Associate-member, Cornell M.E., broad engineering experience capable of handling men, now holding manufac-

turing executive position desires change. Would also consider position which requires knowledge of sheet steel for various requirements.

J-290 Member, technical education and fourteen years' general engineering experience, perfectly familiar with design, construction and operation of plants manufacturing cement, coal mining and coking plants; has made an especial study of elevating and conveying machinery in connection with cement making and coal handling. Has held positions as chief draftsman, mechanical engineer and superintendent. Now employed but to avoid traveling desires to get in touch with large company where experience and ability may gain him a permanent position.

J-291 Experienced designer with broad experience in metal-working machinery and tools wishes to get in touch with concern which would undertake the manufacture of new line of medium sized machines. Location middle west.

J-292 Associate-member, fourteen years' experience in operating and superintending power plants, at present holding position as chief engineer of several plants, desires similar position or one as erecting superintendent, foreman or maintenance man. Position preferred where there is an opportunity to work up to executive position.

J-293 Junior member, Columbia graduate, experienced in design and construction work, desires permanent position in New York or vicinity. Prefers commercial or sales work. At present employed.

J-294 Associate-member, age 41, Lehigh University graduate in mechanical engineering, with eighteen years' varied experience in mechanical, electrical and civil engineering lines, involving design, supervision and direct charge of construction work, plant operation, purchasing, reports, etc., all in connection with electric railways, lighting plants, power and industrial plants, wishes an executive position as manager, superintendent, or sales engineer, with large field and responsibility. At present employed. Southern location preferred.

J-295 Member, graduate of United States Naval Academy, age 33, married. At expiration of six years' active service in the Navy, resigned honorably; has been several years in the employ of large corporations in executive position, desires operating executive position, or other connection, where education, experience and capacity for work count. Location immaterial.

J-296 Member, mechanical engineer, age 35, graduate of Worcester Polytechnic Institute, twelve years' practical experience in design, construction and operation of machinery and manufacturing equipment for power plants and machine shops, also building construction. Ten years with present company. Has had broad experience in work of brass and iron foundries, grinding, polishing, japanning, plating, forging, hardening and machine departments, also in plumbing, millwright, carpenter, electrical and plant work. At present in charge of engineering department for large concern.

J-297 Member with fifteen years' experience in the development and application of pumping machinery would like engagement with large industrial works. East preferred.

J-298 Member, technical man with twenty years' experience in designing, building and general engineering work, capable of managing and assuming responsibility, energetic, ambitious and reliable, desires position with well established company. Location preferred, eastern states.

J-299 Member, age 37, graduate Massachusetts Institute of Technology, thoroughly experienced in the design, development and manufacture of special automatic machinery, dies, tools, electrical devices and fittings of all kinds, furnaces, electro-galvanizing, etc., has taken out a large number of patents, A1 executive, knows what economy in production means and how to obtain it. At present chief engineer of large corporation, but desires to change.

J-300 Junior member, age 26, Swarthmore graduate, at present superintendent of factory making fire apparatus, familiar with costs, brass foundry and forge shop production, desires position in engineering department of concern manufacturing standardized products. Salary $150. Location eastern states, preference, Philadelphia.

J-301 American Member of the Society, technical graduate who has resided in China for the past five years, with wide experience with machinery, would like to get in communication with American firms wishing to open branch manufacturies in China or who would like an agent to represent them in that country.

J-302 Graduate mechanical and chemical engineer with four years' teaching, and various power plant and oil mill experience, desires responsible position with some mechanical-chemical industry. At present employed.

J-303 Technical graduate, M.E. and C.E., with wide experience in teaching and consulting engineering work, wishes position as chief engineer or professor of mechanical engineering in university of good standing. Speaks French. Salary $4000.00. Is open for immediate engagement.

ACCESSIONS TO THE LIBRARY

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A.I.E.E. and A.I.M.E. can be secured on request from Calvin W. Rice, Secretary of Am. Soc. M. E.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Transactions, vol. 36. *New York, 1915.*

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Proceedings, June 22-25, 1915. *Milwaukee, 1915.* Gift of Association of Railway Telegraph Superintendents.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS. Proceedings, June, 1915. Gift of Association.

BUREAU OF RAILWAY ECONOMIES. List of references on the use of Railroads in War. *Washington, 1915.* Gift of Bureau of Railway Economics.

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE. Year Book, 1915. *Washington, 1915.* Gift of Carnegie Endowment for International Peace.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS. Papers and Transactions for 1914 and Proceedings of the 31st Annual Meeting, Feb. 9-10, 1915. *New Haven, 1915.* Gift of Connecticut Society of Civil Engineers.

GRAPHIC METHODS AND THE PRESENTATION OF THIS SUBJECT TO FIRST YEAR COLLEGE STUDENTS, M. F. P. Costelloe. Reprint from The Nebraska Blue Print, Apr., 1915. Gift of Iowa State Drainage Association.

INDEX OF PAPERS AND SUBJECTS DISCUSSED BY RAILWAY CLUBS FROM MAY 31, 1914-MAY 31, 1915. Gift of New York Railroad Club.

IOWA STATE DRAINAGE ASSOCIATION. Proceedings of Eleventh Annual Meeting, 1915. *1915.* Gift of Association.

MÜNCHEN. KÖNIGLICHE BAYERISCHE TECHNISCHE HOCHSCHULE JAHRESBERICHT, 1913-14. Gift of Königliche Bayerische Technische Hochschule in München.

————Programm., 1914-15.

NEW JERSEY. PUBLIC UTILITY COMMISSIONERS. Fifth Annual Report, 1914. *Trenton, 1915.* Gift of New Jersey Public Utility Commissioners.

NEW ORLEANS, LA. SEWERAGE AND WATER BOARD. Thirtieth Semi-Annual Report. *New Orleans, 1914.* Gift of Sewerage and Water Board.

PHILADELPHIA. DEPARTMENT OF PUBLIC WORKS. Annual Report, 1913. *Philadelphia, 1913.*

————Highways. A problem in municipal housekeeping.

————Plain talk about public works. *Philadelphia, 1914.* Gift of A. S. M. E.

PROPERTIES OF STEAM AND AMMONIA, G. A. Goodenough. *New York. John Wiley & Sons. 1915.* Gift of Publisher. Price $1.25.

These tables are based on formulae published in Bulletins 66 and 75 of the Engineering Experiment Station of the University of Illinois. They give the thermal properties of steam saturated and superheated and ammonia, with the necessary logarithms and conversion tables. W. P. C.

RAILWAY LIBRARY AND STATISTICS, Slason Thompson, 1914. *Chicago, 1915.* Gift of author.

ROYAL SOCIETIES CLUB. Rules, by-laws, list of members. *London, 1914.* Gift of A. S. M. E.

SPECIAL LIBRARIES, R. H. Johnston. Reprint of Manual of Library Economy, Chapter VIII. *Chicago, 1915.* Gift of Bureau of Railway Economics.

STREET PAVING AND MAINTENANCE IN EUROPEAN CITIES. A Report by H. W. Durham. *New York, 1913.* Gift of Ralph Folks, Commissioner of Public Works, Borough of Manhattan.

THEORY AND EXPERIMENTS IN FOLLOWING PLANE MACHINES. Charles R. Wittemann. *1915.* Gift of Aeronautical Society of America.

TUFTS COLLEGE. ANNOUNCEMENT OF THE ENGINEERING SCHOOL 1915-16. *Tufts College, 1915.* Gift of Tufts College.

VALVES AND VALVE GEARS, F. DeRonde Furman. vol. II. *New York, John Wiley & Sons, 1915.* Price $2.00. Gift of publisher.

This volume treats of valves for gasoline, gas and oil engines, and is illustrated by detail drawings. W. P. C.

GIFT OF MRS. DAVID N. MELVIN.

Mrs. Melvin has presented to the Society all of the books forming the technical library of her late husband, a member of the Society since 1880. The collection, about 500 volumes, comprises a set of Engineering and Van Nostrands Eclectic Magazine, a set of the Transactions of the Society, and a large collection of modern textbooks.

GIFT OF C. W. RICE

INSTITUTION OF CIVIL ENGINEERS. Descriptive Pamphlet of New Building. Jan. 1914.

LAND GRANT COLLEGE ENGINEERING ORGANIZATION. Proceedings Jan. 24, 25; Nov. 11-14, 1913.

LA VIE INTERNATIONALE. Tome V, nos. 1-2. *Bruxelles, 1914.*

EXCHANGES

BROOKLYN ENGINEERS' CLUB. Proceedings for 1914. *Brooklyn, 1914.*

INSTITUTION OF MECHANICAL ENGINEERS. Proceedings 1915. Jan.-June. *London, 1915.*

TRADE CATALOGUES

BRISTOL COMPANY. *Waterbury, Conn.* Bristol Recording Instruments, Panama-Pacific Exposition.

CLEVELAND TWIST DRILL CO. *Cleveland, Ohio.* Drill Chips, August 1915.

FLANNERY BOLT CO. *Pittsburgh., Pa.* Staybolts, August, 1915.

LESCHEN, A. & SONS ROPE CO. *St. Louis, Mo.* Leschen's Hercules, August 1915.

PUSEY & JONES CO. *Wilmington, Del.* Super-Calendar, August 1915.

VALLEY IRON WORKS CO. *Appleton, Wis.* The Beater, August, 1915.

WALWORTH MFG. CO. *Boston, Mass.* Walworth Log, August 1915.

UNITED ENGINEERING SOCIETY

A B C OF IRON AND STEEL, A. O. Backert. *Cleveland, 1915.*

AMERICAN TABLE OF DISTANCES, specifying distances to be maintained between storage magazines for explosives and inhabited buildings, public railways, public highways. (Pamphlet no. 2, Institute of Makers of Explosives). *1914.* Gift of Institute of Makers of Explosives.

BRASSEY'S NAVAL ANNUAL, 1915. *London, 1915.* (Purchase.)

CASE HARDENING OF STEEL, Harry Brearley. *London, 1914.*

CHLORINE CONTROL APPARATUS FOR WATER AND SEWAGE PURIFICATION. Gift of Wallace & Tiernan Co.

COLLECTED DIPLOMATIC DOCUMENTS RELATING TO THE OUTBREAK OF THE EUROPEAN WAR. *London, 1915.* Gift of Carnegie Endowment for International Peace.

ENGINEERING DIRECTORY, pts. I-II, 1915. *Chicago, 1915.*

EVIDENCE AND DOCUMENTS LAID BEFORE THE COMMITTEE ON ALLEGED GERMAN OUTRAGES. *New York.* Gift of Carnegie Endowment for International Peace.

GRAPHICAL REPRESENTATION OF CERTAIN VITAL FEATURES OF THE NATURAL GAS INDUSTRY IN THE UNITED STATES, prepared by S. S. Wyer. *Columbus, 1915.* Gift of author.

LA MARBRERIE. By M. Darras. *Paris, 1912.*

LLOYD'S REGISTER OF YACHTS, 1915. *London, 1915.*

MOODY'S MANUAL OF RAILROADS AND CORPORATION SECURITIES. Vol. II,—Industrial and Public Utility Section. 1915. *New York, 1915.*

NEW YORK TIMES INDEX. Vol. II, April-June 1915. *New York, 1915.*

OSBORN'S TABLES OF MOMENTS OF INERTIA AND SQUARES OF RADII OF GYRATION. ed. 5. *Cleveland, 1905.*

PURCHASING, C. S. Rindsfoos. *New York, 1915.*

RULES FOR HANDLING, STORING, DELIVERING AND SHIPPING EXPLOSIVES (Pamphlet no. 5, Institute of Makers of Explosives). 1914. Gift of Institute of Makers of Explosives.

SAFETY AND SHORT TRAINS, Marcus A. Dow. Gift of author.

SHRAPNEL AND OTHER WAR MATERIAL. A reprint of important articles presented in the "American Machinist" from January to June 1915. *New York, 1915.*

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS. Ed. 4. *New York, 1915.*

STANDARD STORAGE MAGAZINES, recommended by The Institute of Makers of Explosives. Pamphlet no. 1. *Chicago, 1914.* Gift of Institute of Makers of Explosives.

TECHNISCHES AUSKUNFTSBUCH, 1915, Hubert Joly. *Leipzig, 1915.*

THEORY AND PRACTICE OF ORE DRESSING, E. S. Wiard. *New York, 1915.*

TRADE CATALOGUES

CARNEGIE STEEL CO. *Pittsburgh, Pa.* Axles and Forgings, Ed. 6, 65 pp.; Structural Beams, Ed. 2, 12 pp.

KOEHRING MACHINE CO. *New York City.* Description of Koehring Mixers.

SIEMENS SCHUCKERT WERKE. *Berlin, Germany.* Drehstrom Fordermaschinen mit Widerstands Regelung, 45 pp.; Elekstrische Fördermaschinen, 27 pp.; Winding Engines, 44 pp.

WALDEN'S A B C POCKET BOOK OF THE PAPER AND STATIONERY TRADES, 1912. *New York, 1912.* Gift of Wm. Harper Davis.

WASHBURN CROSBY CO. *Minneapolis, Minn.* Wheat and Flour Primers, 20 pp.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ABRIDGED LIST OF OFFICERS AND COMMITTEE CHAIRMEN[1]

JOHN A. BRASHEAR, *President* CALVIN W. RICE, *Secretary*

Finance Committee, R. M. DIXON

House Committee, S. D. COLLETT

Library Committee, Leonard Waldo

Committee on Meetings, J. H. BARR

Committee on Membership, W. H. BOEHM

Publication Committee, C. I. EARLL

Public Relations Committee, M. L. COOKE

Research Committee, R. C. CARPENTER

Committee on Constitution and By-Laws, JESSE M. SMITH

LOCAL MEETINGS

Atlanta: Earl F. Scott
Boston: H. N. Dawes
Buffalo: David Bell
Chicago: H. M. Montgomery
Cincinnati: J. B. Stanwood
Los Angeles: W. W. Smith
Milwaukee: L. E. Strothman
Minnesota: Wm. H. Kavanaugh
New Haven: H. B. Sargent
New York: Edward Van Winkle
Philadelphia: Robert H. Fernald
San Francisco: Frederick W. Gay
St. Louis: Edward Flad
Worcester: Paul B. Morgan

[1] A complete list of the officers and committees of the Society will be found in the Year Book for 1915, and in the January and July 1915 issues of The Journal.